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The Economic Future of the Bituminous Coal Industry  
in the United States

by  
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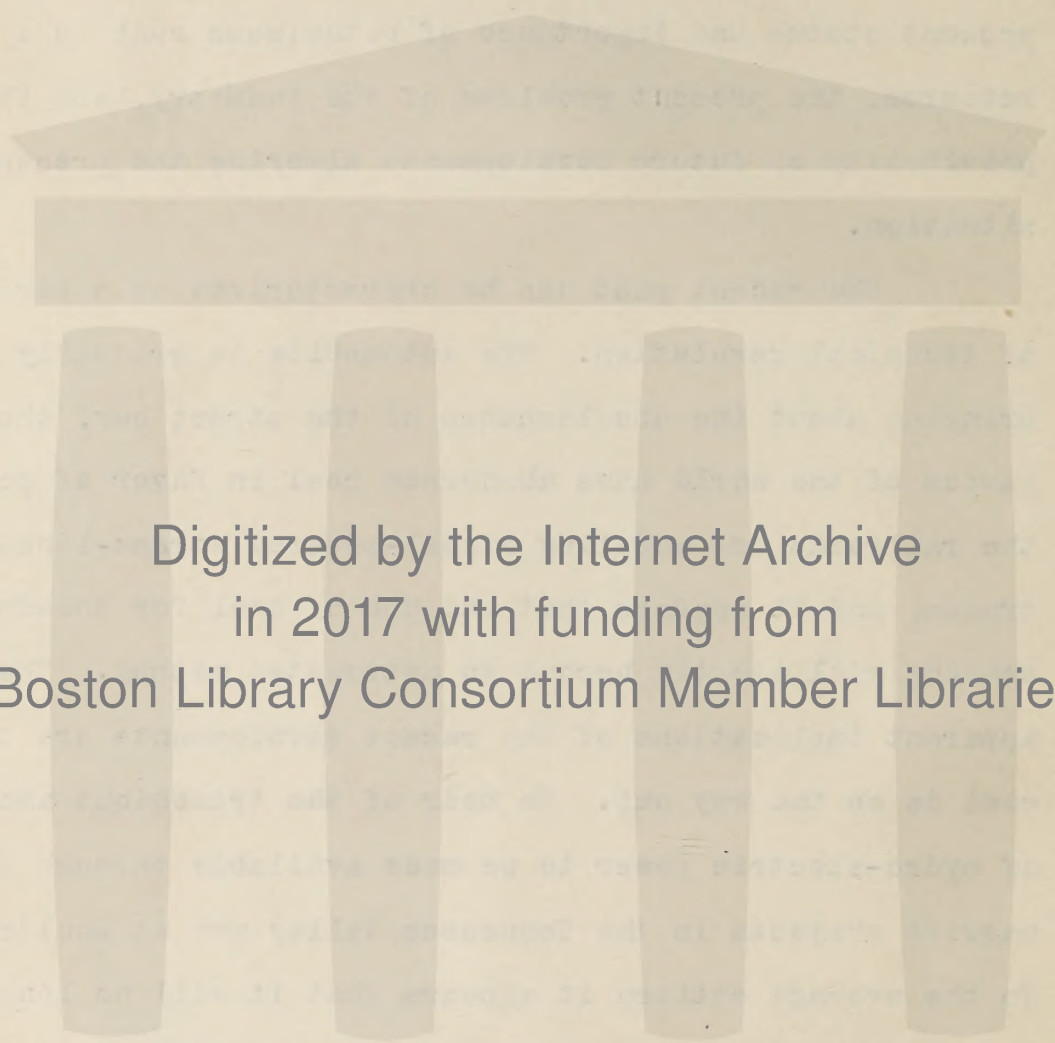
## INTRODUCTION

The problem of this thesis is to set forth the present status and importance of bituminous coal as a resource, the present problems of the industry, and the possibility of future developments altering the present situation.

The recent past can be characterized as a period of technical revolution. The automobile is gradually bringing about the obsolescence of the street car, the navies of the world have abandoned coal in favor of petroleum, the railroads are adopting diesel-powered stream-lined trains, and it appears that the use of coal for household heating will shortly become (an) antiquated (method). The apparent implications of the recent developments are that coal is on the way out. We hear of the tremendous amount of hydro-electric power to be made available through the massive projects in the Tennessee Valley and at Boulder Dam. To the average citizen it appears that it will no longer be necessary to use coal as a source of electrical energy.

Since this is an age of power, anything that alters the amount of power available or its source is of the greatest importance to society. Society has committed itself to total dependence on power utilization.

Recent technical advancement has brought about the popular belief that bituminous coal is soon to pass its greatest stage of usefulness. I sought through this study to discover as near as possible, both in nature and extent,



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the effect of technical advancement upon the present and future importance of the resource.

In approaching the problem, I had little knowledge of the subject and no convictions concerning the result. I made my approach with nothing but curiosity. After a lengthy study of literature on the subject, the conclusions were reached. Some of them were quite apparent from the collected information, but those concerning the future were to a great extent the result of reflection. The sources of information used were the most recent available. I discovered, however, that sources originating over a decade ago were as reliable as could be obtained, for there has been no extensive amount of study conducted in this field recently, and the most recent articles generally substantiated the information in those of older origin. The Code of Fair Competition for the bituminous coal industry states that the situation has remained fundamentally the same for the past ten years.





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## CONDITIONS WITHIN THE INDUSTRY

The general organization of the Bituminous coal industry in the United States is based on a policy of "muddling through somehow." The industry is built upon a system of paradoxes. There is too much organization in the sense that for too many individual industrial associations are in existence, and too little in the sense that this multitude of organizations fails to accomplish its objective. These associations base their excuse for existence on several vague and often conflicting propositions which are believed to possess the power, to cure some, if not all, of the many ills of the industry. The failure of industrial associations to greatly improve the plight of Bituminous coal results from several unfortunate situations. First, there are too many. Competition between associations is the natural consequence. Second, the problems with which the industrial associations have chosen to grapple are not the basic problems of the industry. Third, whatever help the associations can give must be entirely local. Fourth, the associations have no governmental authority. Thus, what they could do or would do remains largely undone.

Tradition is an important drawback to the industry. It is understood that if an operation has been performed in a certain way during the past, that way is the only way to do it. Custom offers stern resistance to all progressive ideas whether they be concerned with industrial organization





or with technical problems of extraction. The lack of records is to a great extent responsible for the strong position of custom in coal mining. Sometimes elaborate records are kept but have little relation to the problems at hand.

"Those who keep records have little idea of their value and make of record keeping a mere ritual in which it makes little difference what is entered, so some entry is made. Or again, records which might be useful to the person in charge of the operation at the mine are kept stowed away in the main office of the corporation in a distant city. It explains in large measure the prevalence of room and pillar mining, with comparatively few variations from Civil War days. It accounts for much opposition to safety devices by both coal operators and mine workers."<sup>1</sup>

The individual mines, the primary facilities for making available the supply, are too numerous. The secondary facilities such as transportation and local distribution organizations are more than adequate. However, notwithstanding these facts, the supply has fallen short of demand three times in the last twenty years. The mine operators blamed the railroads, and the railroads blamed the mines and the government. Doubtless the blame was placed on the right shoulders for the lack of foresight,

1 The Case of Bituminous coal, p. 47.

or with technical problems of extraction. The lack of records is to a great extent responsible for the strong position of union in coal mining. Sometimes elaborate records are kept but have little relation to the problems at hand.

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lack of coordination, the neglect, and red tape on the part of all three were at the bottom of the difficulty.

There are approximately nine thousand mines in a position to ship coal. Four hundred of these have an annual capacity as great as 200,000 tons. Three Thousand eight hundred mines have an output of 10,000 tons. These smaller mines occupy an important place in the industry for in 1922 two-thirds of the total tonnage came from mines with an output under 200,000 tons, and a fourth from mines with less than 50,000 tonnage.<sup>1</sup> It is practically impossible to state exactly how many enterprises are engaged in mining Bituminous coal, for many are not much more than holes in the ground. These small "wagon" mines may operate today and cease to operate tomorrow, and perhaps, resume operations in a few weeks, months, or years. On an average about half or the tonnage comes from companies with an annual output of 500,000 tons or more each.<sup>2</sup> In general, then, it would require two hundred companies to produce over 50 per cent of the tonnage.<sup>3</sup>

Individuals and partnerships operate mines, but the corporate form of organization is dominant. "Two-thirds of the mining enterprises are corporations."<sup>4</sup>

1 Hamilton and Wright, The Case of Bituminous coal. p.62

2 Tryon and Hale, Coal in 1922, pp. 538-40

3 Case of Bituminous coal. p.42

4 U.S. Census of Mines and Quarries 1920, p. 264.





Since 1890, the industry has ever stood ready to produce more coal than could be used. New mines have been opened, until the last ten years, faster than old ones have been abandoned. The coal industry has grown up haphazardly without any sign of guidance, control, or coordination, without much regard for economic laws and less for national prudence expressed in the conservation of national resources. Today it is shiftless, awkward, ponderous; it consumes an undue portion of the national economic wealth. The coal industry has failed to provide its workers with a good life. Although labor costs are high, the miners have a low standard of living.

Mining is today one of the most hazardous occupations in the country. About 2000 miners are killed annually in the course of their employment, and it is estimated that total number of non-fatal injuries runs between 50,000 and 150,000 per annum.<sup>1</sup> The high death rate is not altogether the result of natural hazards of the industry. The United States Bureau of Mines estimates that at least half of the annual deaths could be prevented. This estimate is the more cogent when viewed in the light of foreign experience. The average rate here of 4.08 per 1000 full time workers is quite exclusive when compared with the rate of 1.13, Great Britain's average for the same period.<sup>2</sup>

1 U.S. Bureau of Mines. Mine Accident Statistics, U.S. Mines, Sept. 1934, Serial No. 2661, p. 1.

2 U.S. Bureau of Mines. Coal Mine Fatalities in the United States and Europe, by W.E. Adams, Serial No. 2378, April 1934, p. 1.

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## LABOR SITUATION

Labor in the Bituminous coal industry is in a precarious position. The workers have little to say concerning their being displaced by the advanced use of machinery, or concerning anything else for that matter. Since many of them live in company owned or maintained camps or villages, they must live by the grace of their employers regardless of the enthusiasm in their dissension. Generally, the coal industry has failed to provide its workers with a good life. Although labor costs are high, the miners have a low standard of living.

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1 U.S. Bureau of mines. Mine Accident Statistics, W.W. Adams, Sept, 1924, Serial No. 2641, p. 6

2 U.S. bureau of Mines. Coal Mine Facilities in the United States and Europe, by W.W.Adams, Serial No. 2592, April 1924, p. 1.





Approximately 700,000 workers are engaged in the Bituminous coal industry.<sup>1</sup> Few of these have a chance to work more than 300 days a year. Some work two or three days a week while orders are unfilled. When no orders are at hand the mines may close down entirely. From 1910-1921<sup>2</sup> the working time at the mines averaged 214 days a year. The U.S. coal commission estimated that in a bad year less than a tenth of the workers have an opportunity to work 215 days. For miners who are lucky enough to work with reasonable regularity, the earnings are comparable to those of the average industrial worker.

The living conditions in the average mining town are very bad. The houses, mostly company owned, are of light construction with paper-board walls and tar -paper roofs. Sanitary conveniences are generally lacking. There is little opportunity for education, to say nothing of opportunity for diversion and culture. The Bituminous operators counted only 62 "accessible" evening schools, 63 free libraries,<sup>3</sup> and 47 reading rooms in 261 communities. Most communities provide elementary schools, but high schools are rare. The available teachers have seldom had more than an elementary school education themselves. Thus the mining towns provide little more for the children than they do for the men, and far less is provided for the women.

1 U.S. Geological Survey Statistics. Mimeographed Abstract

2 Hamilton and Wright. The Case of Bituminous coal, p. 78.

3 Living conditions in the Bituminous coal fields, submitted to U.S. coal commission by the Bituminous operators special committee, Sept. 20, 1923. Table opposite p. 28.





In the union fields, the miner has some status because he has a voice in the system of collective bargaining. The living conditions are usually a little better than in the non-union fields because the unions prevail in mines located in urban districts. Hence the worker does not have to live in a company owned house. In non-union fields, however, occasionally there is a system of "workers representation" which gives him something to say about matters of minor importance, but in most non-union fields, civil rights are unknown to the worker.

"In the company towns all the legal and economic powers of ownership lie with the mining corporations. Without exceeding the powers which the law gives and the courts award, they can take from the workers all those rights and privileges summed up under the name of civil liberties. How far they do so is another question. Doubtless suppression for suppression's sake is not indulged in. Doubtless, too, in many communities the worker is not ordinarily conscious that he has no civil liberties but only those rights which he enjoys by grace of the coal operator. But when the organizers of the United Mine Workers appear in the neighborhood, the mining corporations use their power of suppression to the utmost limit. The towns are "closed" to agents of the United Mine Workers and any who are suspected of being friendly to their cause. Workers who stop work or who show sympathy

Hamilton and Wright, *The Case of Bituminous Coal*, p. 91.

April 10, 1924, p. 522.  
 3. Eucharial Chafee, Chairman, Coal and Civil Liberties. A report to the U.S. Coal Commission, presented August 11, 1923.





thy with the union are cast from their homes into the streets."<sup>1</sup> The managers of the corporations consider the homes the workers occupy just as much the property of the companies as the mines, the pumps, fans or dynamos."<sup>2</sup> The number of mine guards is increased, for "defence" purposes. Public meetings of any kind are forbidden.<sup>3</sup>

Labor in the coal industry is faced with several severe problems. The worst of these is that of unemployment. The mechanization of the mines is bound to greatly reduce the need for human energy. It has been variously estimated that with a partial mechanization of mining operations, the present demand for coal could be met with the labor of 150,000 to 200,000 men. The workers are anxious to know when this situation will be realized. Will it come about gradually, and through a period of adjustment, or will the ax fall suddenly? If so, where will it strike first? Will the present knowledge and skill of the miners have any value under the new system? If there is a sharp reduction in mine labor requirements will industry be able to absorb the surplus? What is going to happen? These are the questions worrying labor.

General use of machinery will increase the fixed costs and necessitate more regular and systematic operation.

- 1 Hamilton and Wright. The Case of Bituminous Coal, p. 91.
- 2 President of Vinton Collieries, Pa., quoted in Coal Age, April 10, 1924, p. 522.
- 3 Zachariah Chafee, Chairman, Coal and Civil Liberties. A report to the U.S. Coal Commission, presented August 11, 1923.





This will assure more dependable employment for those able to remain. And the increased economies brought about through the reduction of waste should bring increased wages to the workers employed. There is also the possibility that the expected economies will reduce the price of coal enough to encourage greater consumption. Thus the reduction in labor may not be quite as severe as was prophesied. There are other advantages which may come to labor and offset some of the disadvantages of machine mining. The worker will have companionship instead of isolation. Less muscular effort will be required, and there will be a reduction in the danger of death.

There is one thing certain, however, and that is the fact that whether or not mechanization comes soon, in the distant future, or not at all, labor must be reduced. There are far too many mines in operation; consequently, the industry chronically suffers from over production. Sometime, in the near future, many of the less efficient mines will be forced into bankruptcy. The coming of machine mining will likely do the job. Those lacking the price of machinery will be forced out, and lack of working capital is a characteristic of the majority of mines.

is the problem of the industry, but it is a problem of demand and not one of supply. The productive capacity stands





PRODUCTIVE CAPACITY

The productive capacity of the Bituminous coal mines is above 1,000,000,000 tons annually. This is approximately twice the annual consumption, and this capacity is exclusive of the impending use of machinery.

If more modern mining methods are applied to one-quarter of the total working area, and if the rate at which the face is advanced is increased by only 50 per cent, the total capacity will be increased to 1,125,000,000 tons, or 625,000,000 tons in excess of present consumption. If one-half of the area is to feel the quickening touch of a technique which advances the face at an increased rate of 75 per cent, the present capacity will be swelled to 1,375,000,000 tons. If in due season, the machine process should make a factory system out of the extraction of coal by a single uninterrupted operation, the face easily ought to be speeded forward at three times its current rate. If this new method were applied to three-fourths of the mining area, the total capacity of the industry would be increased to 2,500,000,000 tons, which is five times the amount of coal which is annually converted to fuel and power.<sup>1</sup>

It is apparent, then, that the productive capacity is the problem of the industry, but it is a problem of demand and not one of supply. The productive capacity stands

1 Hamilton and Wright, The Case of Bituminous Coal, p. 168.





as a threat, but it is a threat of superabundance rather than one of scarcity. Industry in general is assured of plenty of coal, the coal industry is assured of plenty of trouble.

The room and pillar method is the oldest and appears to be the obvious way of developing a mine. This assumption accounts for the current prevalence of this system in the American mines. It is, however, the most wasteful. Main arteries are run from the bottom of the shaft. Passageways or "entries" are set off at right angles from the arteries. From these entries, which are set off at regular intervals, "rooms" are marked off left and right. There are large "pillars" left standing between the rooms. <sup>1</sup> When this system came into existence no one thought of possible alternatives. Many still consider it the logical way of operating a mine. This method can accommodate as many workers as the management might wish to employ, because there can be provided any number of "rooms" or working places as there are workers. Since one miner works in a room, he has full direction of the work at the face. Thus there is little opportunity for organization or coordination of the work. As a matter of fact, until recently, no one thought or cared about organization. <sup>2</sup> The great waste of this system results from the leaving of huge ridges of coal to hold up the "roof."

1 Transactions of the American Institute of Mining and Metallurgical Engineers, Vol. LXVI, p. 125.

2 C.E. Gilbert and J.E. Froese, Bulletin 102, Vol. 1, United States National Museum, p. 22.





## METHODS OF PRODUCTION

The room and pillar, the long wall, and the panel systems are the principal extractive methods now in vogue.

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1 Transactions of the American Institute of Mining and Metallurgical Engineers, Vol. LXVI, p. 183.

2 C.E.Gilbert and J.E.Progue, Bulletin 102, Vol. 1, United States National Museum, p. 23.





The "long-wall" system has not been used extensively in this country even though its employ allows almost all of the coal to be taken out. Here the floor of the mine is broken into quadrilaterals or "panels", bounded by mains and entries. The coal is taken off all along a "long-wall" constituting one side of the panel. As the extractive process continues, this wall is usually kept at a right angle to the entry. If the work starts close by the shaft pillar and is driven outward, the working is said to be "advancing". If, on the contrary, an entry is driven to the edge of the working and the coal is taken on the way back, it is termed "retreating". The principal disadvantage of this system is that the worker must spend much of his time protecting himself against breaks in the roof overhead. Unless the seam of coal is very narrow, the miner has to build behind him pack walls. Even roadways often have to be buttressed. The unproductive work required accounts for a very large cost item, especially where stone is not very abundant and timber has to be used.<sup>1</sup> The use of the long-wall mining system in the United States is restricted therefore to mines where the seams of coal are narrow and falling roofs are not a great threat.

The panel system is a modification of the room and pillar method. The modification was brought about in order to permit efficient use of machines in the few mines where

<sup>1</sup> Hamilton and Wright. The Case of Bituminous Coal, p. 127.  
<sup>2</sup> Davis and Duggan. "Pillar Driving in Bituminous Coal Mines."  
 1 Hamilton and Wright. The Case of Bituminous Coal, p. 111.





machine extraction is employed. Under the panel system the mining area is cut into rectangular sections or "panels", bounded by entries. Rooms are driven by machines across the panel leaving pillars between. Then, from right to left, or from left to right, the pillars are drawn in proper order. When the operation of pillar drawing is in progress, the work on the pillars is so synchronized, that at any given moment a straight line, touching the upward and outer corner of the undrawn portion of each pillar, will cut across the panel diagonally. The object is to control the roof so that the break, which is certain to come eventually, will occur behind the working line and over the part of the mine which has been worked out. If careful supervision, aided by maps kept up to date, can keep the work in line, the pillar drawers, whose work lies back of the line, will be safe.<sup>1</sup>

An ingenious method, frequently employed for drawing pillars is known as the pocket system. First, an incision or "pocket" is driven many feet into the pillar a short distance from the extreme end and then the coal in the "stump", or the section of the pillar between the pocket and the outer edge, is extracted. Again the pocket is driven, the stump is removed, and the process is repeated until the pillar is drawn.<sup>2</sup>

1 Hamilton and Wright. The Case of Bituminous Coal, p. 127.

2 Pryde and Magraw. "Pillar Drawing in Thick Coal Seams," Transactions of the American Institute of Mining and Metallurgical Engineers, Vol. LXVI, pp. 415-21.





The V system, which is a clever combination of the panel system and long-wall mining gives great promise. The few experiments in V system mining which have been carried out have been rewarded with considerable success. The panel method is an adaptation of machine extraction to an old hand method of mining. The V system is an idea constructed from its very inception for machine mining. The intention to make the most economical use of all known mechanical tools was systematically carried out. The rectangles which make up the floor are divided into long strips, each of which is mined along two diagonal faces, which together form a V. The coal is carried away by face conveyors which at the point of the V empty into larger ones. These, in turn, transport the coal along a narrow passage and at the entry dumps it into cars. Since the length of the diagonal faces and the angle of the V are alike subject to variation, the method is a very flexible one.<sup>1</sup>

The most important phase is the tendency of the newer schemes of extraction towards long-wall mining. If the influence of the machine will not force it, "the needs of ventilation, supervision, and drainage will do so."<sup>2</sup>

1 Brosky, A. E., Coal Age, Feb. 7, 1924, pp. 197-203.

2 Coal Age, March 26, 1925, p. 457.





## EFFICIENCY IN MEETING DEMAND

If having an adequate supply of coal on hand to fulfill the day-to-day requirements of industry can be taken as a criterion of efficiency in meeting demand, the Bituminous coal industry is efficient in this respect. In general, the industry has at all times sufficient coal ready to be shipped, in transit, or at the local points of distribution to satisfy all of the industrial needs of the country. Although the supply has fallen short of demand a few times in the past two decades, the entire fault cannot be placed on the shoulders of the Bituminous coal industry. Lack of coordination, of the industry itself, lack of coordination within the transportation system, labor difficulties and, to some extent, governmental red-tape, all played a significant part on all of the occasions when the demand was not satisfied. With the exception of the above mentioned failures, the industry serves its purpose satisfactorily. The usual condition of supply is one of superabundance rather than shortage. Overproduction has, especially during the past twenty years, been a chronic ailment. More significant than production itself is the fact that the capacity of the industry to increase the daily output of coal has for several years been far greater than the average production, not to mention the consumption. Of course there are many places of coal production that are shamefully inefficient. Inefficiency and waste in extractive





methods, over capitalization, transportation waste and many other cases of inefficiency could be named, but I prefer not to classify them as inefficiency in meeting demand. Such phases do not bear directly on the supply of coal available to the consumer.





## DUPLICATION OF CAPITAL AND WASTE

Mention has been made of the fact that the Bituminous coal industry has productive capacity for in excess of the possible consumption. Such a situation represents wasteful use of a great portion of the national economic resources through duplication of capital. There are far too many mines in operation and each individual mine represents capital outlay varying from a few thousand dollars to several millions of dollars. The situation stands for much idle or at least, partially idle capital which might be serving a valuable economic purpose elsewhere. At present, with no particular change in the backward extractive methods now in vogue in the majority of the mines, the industry is capable of producing at least one billion tons of coal annually. The average production is approximately half a billion tons, and even at that rate of production the industry is ahead of demand. Thus with the prevalent use of backward extractive methods half of the capital involved is idle all of the time. And this is not the end of the difficulty, for, as stated above, if three-fourths of the industry should adopt the most efficient methods of extraction accompanied by the use of machinery, the productive capacity would be about two and one-half billion tons or five times the amount that could be sold. The waste in materials and equipment, great though it is, is not the only phase of wastefulness in the industry. It





is well known that it uses almost 700,000 men to do the work that no more than 500,000 could do without increasing the average daily output per man. It divides among 700,000 the wage that would not provide luxuries for the smaller group.





## WASTE IN EXTRACTIVE METHODS

One would assume that with the threat of over-production always at hand, each mine operator would do all in his power to gain the utmost efficiency. One would think that the industry would be composed exclusively of well run mines fully abreast of other industrial establishments in the use of scientific methods. But the actual situation is<sup>1</sup> very different.

"Generations of consumers yet unborn may charge the present coal industry with carelessness. It has not protected their interests with even the diligence that was expected. In some ways, to be sure, it has been better than the promises of a competitive regime. It has not confined itself to mining the best coal, leaving only the less desirable for future generations. Instead, seams that are thick, and seams that are thin, those with faults and those without, are all mined today, although the requisite supply could be obtained from the better seams. In other respects, however, the present order has inexcusably neglected the interests of the future. It has left coal in the ground which could have been taken out. This is permanently lost, or can be recovered only with great difficulties, at an almost prohibitive cost."<sup>2</sup>

Coal Age talks of the mechanization of the mines as "resolute modernization," a "new world for the mining man,"

1 Hamilton and Wright. The Case of Bituminous Coal, p. 61

2 Hamilton and Wright. The Case of Bituminous Coal, p. 74





and the big change which is coming."<sup>1</sup> It declares that the time is ripe for a radical revision of mining methods, that "the plough has thrust its sharp edge into the field of industry, it has disturbed the ground, and if the seed is planted a bumper crop of new and better methods may be expected."<sup>2</sup> The trade journals, however, are far ahead of common practice in the industry. There is much promise in the idea of modernization of mining operations in the fact that the acute competition in an over-expanded industry probably will become even more severe.

There are three outstanding forces working toward machine mining. Because of the stress of competition and the high initial outlay involved in the installation of cost saving equipment, "snow-birds" and "fly-by-nights" will be forced out of business. As a result, their tendency to swell mine capacity will cease to be a disturbing influence to the industry. The second is that the mines which remain will be bigger and more concentrated.<sup>3</sup> With machine mining the face will be advanced more rapidly. This will result in a "balanced mine" with its processes articulated, and its operations concentrated enough to allow proper oversight.<sup>4</sup> Even though the daily output be greater than even the larger mines know today, there will no longer be a diffusion of

1 Coal Age, May 21, 1925, p. 743.

2 Ibid, March 12, 1925, pp. 388-9.

3 Hamilton and Wright. The Case of Bituminous Coal, p. 99.

4 Anderson, C. E., Balances Mines, Coal Age, May 1, 1924, p. 637.





operations resulting from "too much mine." The third is that there will appear a tendency toward consolidations. The new methods entail a great decrease in direct costs and a corresponding increase in overhead costs. Thus, in order to keep expenses low, they must be spread over large tonnage, and this demands regular operation.<sup>1</sup> This situation can best be met by the grouping of several mines under a single management. Thus it will not be necessary to run many mines irregularly when demand is slack. Instead the combination can concentrate its work on a few production units.<sup>2</sup>

The colossal waste and inefficiency of present mining practice goes to the very root of the industry. The room and pillar system, which has already been described, is an example. That it is the prevailing method of extraction in the majority of individual mines is freely admitted. One of the chief sources of waste of this method is the large amount of coal left underground. Since direction of the work rests with the man at the face, there is practically no organization. Hence, little attempt is made to draw pillars, and huge ridges of coal are left standing.

The following quotation gives an idea of the mechanical organization of the average mine.

"The lack of bother about system is typified by the purchase and maintenance of equipment. In the good old days

1 Ibid, May 8, 1924, p. 661.

2 Coal Age, May 21, 1925, p. 743; May 1, 1924, p. 626.





cars were pushed by human beings or drawn by mules to the shaft or to the surface. When modern transport came purchases were made in a haphazard way. Locomotives were installed without reference to the specific work they had to do, gauges were neither standardized nor related to the volume of coal to be carried, cars of miscellaneous sizes were wastefully strung together for haulage, and, in many cases rails of different weights and sizes, with many a bad joint, to give adventure and variety to underground transport, were spliced together into a track."<sup>1</sup>

Such disorganization and lack of planning reaches through all phases of mine equipment. The fans, hoists, boilers, pumps, and other paraphernalia have been acquired casually, item by item, without any consideration of the specific requirements of the work to be performed. Their purchases were made grudgingly when output demanded them. Ventilation, which is necessary to carry off noxious gasses and explosive coal dust, is too often inadequate. There are even mines today which rely exclusively upon the old fashioned furnace intended to heat air and start a current in the right direction."<sup>2</sup>

There is no organization of haulage; track, locomotives, cars, shaft, tippie capacity have seldom received any attention in regard to coordination or apportionment.

<sup>1</sup> Hamilton and Wright. The Case of Bituminous Coal, p. 110.

<sup>2</sup> Moor, E.S., Transactions of the American Institute of Mining and Metallurgical Engineers, Vol. LXVI, p. 517.





The necessity of relocating the haulage system, as the work progresses, for efficient operation is not generally recognized. Operators are wont to consider the getting of coal as mining, getting it out of the mine is quite incidental. The result of this situation is too much capacity at one point and too little at another. Thus there is waste in management and equipment with no economy in the use of labor.

The work of the individual miner is little supervised. Since he is considered to be a craftsman, he is supposed to carry on his work without direction. One foreman has charge of approximately one hundred miners, more or less, according to the size of the mine. He does not use records or maps, but carries in his mind all of the knowledge upon which the work of scores of men depends. He makes his daily round of the mine, often covering several miles of shafts and passageways, and when he is needed at any given point he is likely to be beyond reach. It logically follows that the old art of mining is a craft developed to a high degree and hampered by many auxiliary tasks. Thus the miner must work slowly, steadily and cleverly. He is held back by waste motion and he must be his own boss. Thus the operating costs are excessively high.

Few mines now in operation have felt the touch of modern engineering in the lay-out of the workings. Consequently the extraction has followed a random course which makes it the more difficult to plan production or to coordi-





nate activities. Since the mines are generally small and scattered, they lack working capital sufficient to make technical improvements or else they are too small to afford much opportunity for radical technical change. However, even the smaller mines could use mechanical devices for tasks now performed by manual labor. The use of mechanical equipment in the more advanced mines will force, through competition, the use of similar equipment in the rest. There is a tendency to apply planning to the layout, organization and development of those mines which are in a position, either physically or financially, to do so. This tendency is equivalent to another competitive spur to greater economy and efficiency. The machine process and planning are practically synonymous for the two go hand-in-hand when applied to mining operations. A properly planned succession of machines would make the mining of coal and its haulage to the tibble a single mechanical process.

The first hint at quantity production through machinery appeared in the undercutting machine. There were many technical difficulties to be overcome before such a machine could be applied satisfactorily. Such things as the pitch of the seam, the hardness of the coal, the presence of impurities, and the thickness of deposits each presented a problem. Such problems, however, have yielded to human ingenuity, and the machine is now flexible and highly practical. The undercutter has been applied successfully to both room and pillar





and long-wall mining. It greatly increases the output and improves the quality of the coal by permitting more lumps to be taken with less slack and dust. Although such machines were available a half-century ago, there were only five hundred in use in 1905. Since that time, they have increased to twenty-thousand, but it is easy to see that this is but a drop in the bucket when compared to the half-million or more miners who would use them.<sup>1</sup>

The next process of coal production is loading. The United States mines produce more than half a billion tons annually and this amount is shoveled into the loaders by human energy. It is apparent that the price paid for this energy is staggering. The machine loader promises to take its place in American mining, but there is a management problem of coordination to be solved before the loaders will work efficiently. "The use of the loader requires a concentrated car-supply; the slow work of loading by hand in many rooms meant a disseminated car supply. Coal men have been rather slow to learn that, if the loader is given a chance, the haulage system must be made over."<sup>2</sup> In a few mines the required coordination has been successfully accomplished and has made practicable the use of the loading machine. There is a loader, the "coloder," manufactured by a West Virginia company, which has been in the process of development since 1893. This machine and others of its

1 American Mining Congress 1929, Coal Mine Mechanization, p. 365.

2 Third Standardization Bulletin of the American Mining Congress, 1923, p. 33.





type have been used successfully under widely varying conditions, and they promise to reduce the mine cost of coal by 30 per cent.<sup>1</sup> The future belongs to the loader unless something more revolutionary appears. Informed opinion states that the "mechanical" loader is inevitable, and its general application waits upon the finance and the courage to mechanize."<sup>2</sup> Modern haulage is rapidly becoming a reality. "When sixteen mules lack the power of a single storage battery locomotive, animal flesh and blood has been doomed."<sup>3</sup> The development of the conveyor has added much to the possibility of reducing costs. The conveyors are used between the face and the entry. "Haulage is greatly simplified where there is no necessity of taking cars into the working places"<sup>4</sup> A still more recent development is the use of conveyors along entries and even along mains. It has been proven possible that coal can be transported from the face to the tippie by the exclusive use of conveyors. Thus it is apparent that technical development offers much to the industry, and, more and more operators are awakening to the possibilities. The present backwardness of extractive methods is yielding to the demands of cheaper coal.

1 Brosky, Alphonse F., "Coloder," in Coal Age, Feb. 5, 1925. p. 215

2 Coal Age, June 4, 1925, p. 824

3 Coal Age, July 26, 1923, p. 174

4 Third Standardization Bullitin of the American Mining Congress, 1923, p. 137





The changes in equipment are causing much attention to be paid to mine development. With a well organized layout great economy is possible. On the other hand the layout holds the possibility of extreme waste. If resources, capital and labors are to be used, foresight is required. Before a new mine is opened, "borings" must be made with a diamond drill, a preliminary survey of the situation taken, and a complete mine plan drawn up. The first consideration must be given to a method in which machines may be most economically applied. The panel system is the best application of machine extraction to old mines. The greatest economy cannot be obtained when machinery is used in old workings, for there is necessity of frequent relocation of the equipment. Regardless of this fact, however machanization would decrease extraction costs to a very considerable extent even in old workings. Of course the ideal situation would be that of a new mine planned for the use of machinery, one in which all factors were coordinated and organized for machine extraction from the very start. This would not only give a lower cost figure for all of the coal mined, but it would also prevent the hampering of future work by past mistakes. Every detail would receive consideration at the hands of a trained technician. The sizes and capacity of cutters, loaders, correctly worked out. The order of work, or the places where coal should be mined first would be planned, as well, the speed of advancing the face would be regulated with the emphasis on





keeping all of the machinery working all of the time. The V system offers much in the way of getting the most coal in the shortest time with the least cost. This is as much as saying that it is the system which gives the greatest return on the invested capital. Unfortunately, this system can be applied only to new mines or, at least, to the unworked sections of older mines, it cannot be used economically to reclaim the wastes in sections worked by the room and pillar method.

If a mine were developed from the very start with the intention of making the most economical use of machinery, much advancement could be made with the long wall system. Perhaps this would even exceed the advantages of the V system, for the machinery could follow closely the workings at the face and they could be operated in a straight line. This would permit the use of the latest developement in cutting equipment, a combination machine that makes cutting, loading and haulage one process. It is composed of a battery of saws which make continuous incisions, followed by scrapers which slice the coal off the face. The same machine pushes the coal onto the conveyor. This linked with others carries the coal to the tippie.

The mechanization of mining has given rise to an even more startling developement, the application of the factory system. The combination machine, first described, makes the factory possible. It eliminates the alternate use of cutter and loader and also the interruption necessary while "firing the shot." In the old process of mining, the face was undercut





several feet by pick, this is now done by the cutting machine. After the coal is undercut, a charge of black powder is placed in the incision and fired. The miner must get a safe distance away and then wait for the air to clear. The loosened coal is then loaded. It is obvious that if this halt could be eliminated, much time could be saved which is now lost. Consequently on that score alone the machine would effect a great saving, not to mention its faster and better quality work. In a mine where this machine was tested, an old craftsman commented<sup>1</sup> "nothing but a damn factory, and a Ford factory at that."

It is readily recognized that the Bituminous coal industry is terrifically wasteful. Wasteful of the resource itself because of the backward extractive methods so prevalent, wasteful of labor because it uses for more than it requires, wasteful of capital because it is greatly overexpanded and cannot keep half of the investment at work, and wasteful in general because of poor management, and lack of coordination both within the individual mines and within the industry.

Although the waste must end and end soon, its very termination will cause difficulties. Machinery could and should be used extensively in extraction. But its use means increased production and the industry is already suffering from accute overproduction. New methods and new equipment must be applied to satisfy the demand of industry for

1 Coal Age, May 28, 1925.p,783





cheaper coal. But, if the machines are to be run economically they must be kept working. To keep them working means to constantly increase the excess of coal. The general use of machinery also means a drastic reduction in the amount of labor employed, for it will reduce the need for human energy as a source of power and use it solely for purposes of supervision. Naturally there will follow unemployment of several hundreds of thousands of men. The industry employs about 700,000 men in a normal year, to do the work that 500,000 men could do without increasing the daily output per man, and without substituting any machinery for human energy. This is pure waste which should be eliminated. But where will the discharged workers go? Industry in general is in no position to absorb them, at least for a while. And, too, when the industry is fully mechanized how many more will be out of work? This situation presents a pretty problem, not only for the coal industry but for the country at large.

The joker in the situation is the fact that no one knows what the outcome of elimination of waste will mean for the individual mine operator. If he installs machinery, he must keep it running or suffer a waste in capital assets. If he does keep it running, he will aggravate the condition of excess production. Industry demands cheaper coal and the mine operator must satisfy the demand or yield the market to other resources.

The introduction of machinery will require a huge





capital investment on the part of the operator. If he is in a position to make the investment, the economies brought about by lower costs may pay handsome dividends. It is beyond doubt that machine operations will reduce costs to an extent that they will pay for themselves within a short time. They will eliminate enough waste of coal through sheer superiority to pay for themselves before they show any signs of wear. But the coal must be sold before any of the economies of mechanization can be realized.

The fundamental situation was aptly pointed out by the salesman who said to a hesitation customer, "maybe loaders wont work in your mines, but the mines that can use them can turn out a damn sight more coal than can ever be sold."<sup>1</sup>

Will the elimination of waste solve a problem of cost but leave an economic problem in its wake? I shall defer the answer until other important factors are considered. But the elimination of waste and the mechanization of the mines must come and will come in the near future. The backwardness of the industry cannot persist for long in the face of great technical change in other industries. The demands for cheaper coal are too threatening to be ignored. The alternative resources are bringing such competitive pressure that industry will get what it demands from the coal operators or turn to other sources of power. The coal mine operators

<sup>1</sup> Hamilton and Wright, The Case of Bituminous Coal, p. 143





'are fully aware of all of the problems of the future market in regard to competition. They will not let the market slip from them if they can prevent it, for the present market is not half big enough.





## TRANSPORTATION FACILITIES

One of the major disadvantages of coal in a competitive sense, is the cost of transportation. Coal represents large bulk and weight compared to the fuel value per ton. If it were not for this fact, its chief competitors, petroleum, natural gas and hydro-electric power, would present no significant rivalry. The pipeline system places petroleum and natural gas in a competitive position; and hydro-electric power, by its intrinsic nature, lends itself to the most convenient type of transportation. Coal not only depends on transportation to give it economic value, but it is also at the mercy of the overland transportation system. This is not entirely true of petroleum, natural gas, and hydro-electric power for the transportation system of these alternate resources exists solely to serve their needs and cannot exist without satisfactory performance of that service. On the other hand, coal forms only a portion of the railroad and ocean freight traffic. Granted that it is an important portion of railroad freight, the entire overland transportation system falls short by a wide margin of depending upon revenue from coal haulage for its existence. The coastal shipping industry depends even less on coal than do the railroads.

Transportation presents a greater problem and a greater hazard to the coal industry than any other phase of making coal available for consumption. From the standpoint





of cost, transportation offers a larger problem than extraction. And from the standpoint of competition, transportation is far more important than mining costs. It is the problem of transportation that gives the other sources of power a competitive footing. If it were not for this problem, industry could afford to use no other source of power than bituminous coal. It might be said, then, that transportation is the problem of bituminous coal, for if there could be a satisfactory solution, all other problems of the industry would solve themselves.

The only facilities for transporting coal on a commercial scale are the railroads and colliers. All coal must be shipped at least part of the way via rail. The freight rates on water transportation are substantially less than the rail charges, but, because of the necessity to utilize overland transportation at both ends of the journey, and to transfer the cargo twice between the two, the advantages of the lower costs of shipping via water routes are usually nullified unless the journey is a long one. However, the differential in transportation costs between the two methods accounts for the fact that under certain price conditions European countries can sell bituminous coal in the United States at a competitive price. This imported coal may be sold at such a price only to consumers located near the larger ports where handling facilities are best. There are other influences bearing on the ability of imported coal to





compete with the product of American mines, and they will be discussed under Foreign competition.

It is the necessity to move coal at all that creates the problem. This, of course, is a physical proposition, integral with the nature of the resource. Thus it is, for all practical purposes, beyond the control of the industry. There will doubtlessly be discovered means of making transportation less and less of an obstacle. But such is not in the picture at present. Because coal belongs to the future even more than it does today, the handicaps of transportation are things to be more severely dealt with as time progresses.

The following figures show the vital part that transportation plays in the delivered cost of coal.

| Mining Costs |                           |                                     | Transportation Costs <sup>1</sup> |                                 |                                     |
|--------------|---------------------------|-------------------------------------|-----------------------------------|---------------------------------|-------------------------------------|
| Year         | Average Price F.O.B. Mine | Percentage of total Delivered Price | Total Delivered Price             | Average Freight Revenue Per ton | Percentage of total Delivered Price |
| 1929         | \$1.78                    | 44.2 %                              | \$4.03                            | \$2.25                          | 55.8 %                              |
| 1930         | \$1.70                    | 43.3 %                              | \$3.93                            | \$2.23                          | 56.7 %                              |
| 1931         | \$1.54                    | 41.0 %                              | \$3.76                            | \$2.22                          | 59.9 %                              |
| 1932         | \$1.36                    | 37.6 %                              | \$3.62                            | \$2.26                          | 62.4 %                              |

The significance of these figures is that; first, the railroad freight revenue per ton is consistantly more than fifty per cent of the delivered price to the consumer; second, that while the price of coal at the mine is substantially reduced, the reductions in freight charges are comparatively small; and third, that when the mine operators are taking a





lower price, the railroads may be demanding a higher one. The increase in freight rates at a time of falling coal prices is not entirely the fault of the railroads for government regulation of rates to some extent ties their hands. But whether it is the fault of the railroads or not, increased freight charges have the same disastrous effect on the coal industry. The attempt of the government to put the coal hauling railroads on their feet is helping to put the bituminous coal industry on its back.





## ADEQUACY OF TRANSPORTATION

From the standpoint of physical facilities, the transportation system is entirely adequate to give time and place utility to all the coal consumed throughout the country. There is an abundance of railroad facilities, including sidings at the mines and rolling stock, available in all the coal mining regions, and reaching all of the points of consumption. Notwithstanding this fact, the railroads have contributed in a large measure to the occasional failure of the coal supply in recent years. The reason was not lack of facilities, but lack of coordination of facilities. With proper foresight, the railroad management could have adequately served any of the industrial peaks. When coal was not delivered in due time, the cry of "car shortage" arose. There was no shortage in the number of coal cars at any time. The shortage resulted from the failure of railroad management to have sufficient cars where and when they were needed. Cars were kept too long on intermediate sidings instead of being hurried along. When emptied at their destinations, they were not rushed back to the mines. Often cars were poorly distributed. A concentration of cars at one point and a scarcity at another has occurred frequently. Such a situation is purely a problem of management. No great mentality is required to enable one to realize that hundreds of cars in Chicago can do little good when the coal is mined in Southern Pennsylvania and wanted in Buffalo.





It is entirely justifiable for the railroads to make sure of their own supply of coal before making deliveries elsewhere, but it is likely that through over-cautiousness, they kept too many cars tied up in proportion to their needs.

Like overland transportation, facilities for moving coal by the water-ways are entirely sufficient, though less easily controlled. For lake, canal, and coastwise shipping, some of the coal hauling railroads operate their own colliers, barges, and tugs, which economically supplement their overland systems. Besides the ocean shipping facilities operated by railroads, there are many coal carrying vessels operated by steamship lines, large consumers, and independent owners. Seldom, if ever, is there a lack of vessels. Usually, the difficulty is lack of cargo. When coastwise coal shipping is insufficient to keep the vessels busy, the liners and independently owned colliers will go anywhere on the globe where cargo is available. Thus, if a sudden demand for ocean transportation arose, a shortage of ships might be evident. Such does not occur frequently enough to cause any concern.

By and large the transportation facilities serve the needs of the industry in a satisfactory manner. The facilities are fully capable of meeting all requirements, and any failures are the result of controlable factors. The high cost of transportation originates from the physical nature of coal. In some degree the carrying expenses are higher than they need to be, but transportation costs will always





represent a major portion of the delivered price of coal as long as it is necessary to transport it.





## TRANSPORTATION WASTE

Transportation waste is of two kinds; that which can be eliminated and that which cannot. The type which cannot be eliminated arises from the necessity to consume a certain percentage in the process of moving it. A certain amount of coal, or some other energy resource, has to be consumed to supply the power needed in its transportation. This amount is a varying factor, dependent upon the vehicle used and the efficiency of that particular carrier. Locomotives use from .0423 to .085 pounds of coal to move a ton of freight one mile. Thus one locomotive may be 100% more efficient in taking the energy from its fuel than another. Ocean transportation is less expensive per ton mile but there is as great variation in the individual efficiency of ships as there is in locomotives. The amount of the waste represented by the energy necessary to move the coal can be reduced to some extent, but it cannot be eliminated entirely.

Needless transportation and circuitous transportation are of the type that can be eliminated. There is another type of waste resulting from transportation which cannot be entirely eliminated, but which could be reduced or controlled. This waste consists of depreciation and shrinkage. Coal is a relatively durable product but, contrary to general belief, it can and does depreciate through transportation, and the shrinkage is the result of this depreciation. Bituminous coal crumbles and powders easily. Therefore, coal with a





large percentage of lumps at the mine may be reduced to a major percentage of slack and dust in transportation. Because coal cars are open at the top, much of the dust is blown away and is a net loss. Some of the shrinkage could be prevented by different loading methods and some flexible covering for the load.





## NEEDLESS TRANSPORTATION

One would suppose that since transportation charges represent more than half of the delivered price of a ton of coal, economic factors would prohibit any such thing as unnecessary transportation. This is not entirely the case. It is well known that freight rates vary with localities and with length of haul. Thus it might be just as cheap to bring coal from a mine a few hundred miles more distant as from one nearer the point of consumption. Freight rate differentials are not the only reason for needless transportation. Low cost mines may be able to quote prices that would offset any difference in transportation costs between these mines and others nearer a particular market. In such cases the range of the potential market is simply greater than it is for mines producing at higher cost. Any rises in the price of coal may make it possible for mines located at greater distances from any given market to offer coal for sale at a net delivered price which puts them on an even competitive basis, or even at a price which gives them a competitive advantage. It has been known for coal to be shipped from West Virginia to Chicago, while Illinois is literally built on top of a coal mine. Then, too, there are cases in which coal may not be available from a handy source while there is plenty available at distant sources. Such a situation can arise from both conditions within the industry itself, and from factors concerning transportation facilities. If





strikes are in progress in one locality, production will be at a stand-still and anyone needing coal must get it elsewhere. Besides this, a large consumer may place a very sizable order which mines near at hand cannot fill within the specified time or at the desired price. The consumer would get the coal from any mine in a position to meet his demands, even though the coal might be brought in from a distance much greater than necessary. Concentration of the car supply may make it difficult to get coal from a near-by source within the required time. It is conceivable that if there is a surplus of cars in Illinois and coal is required in New York State, the pressure of time may force the ordering of the coal from an Illinois source instead of from Pennsylvania or West Virginia. This is possible because, for all practical purposes in this situation, coal is available from Illinois and not from Pennsylvania or West Virginia. The Interstate Commerce Commission has done its best to regulate and maintain an equitable distribution of coal cars but it has failed to rectify the situation. Everything appears to be satisfactory at one time, and a sudden increase in demand at any given point would create a car shortage. Many times the attempts by the Government to maintain equitable distribution of available cars has resulted in a car shortage at certain points where such would not have happened had the Government not attempted to regulate the distribution of cars. The attempts at regulation have impaired the flexi-





bility of the transportation system with the result that cars were available where they were not needed and absent where they were required. Naturally, needless transportation was the result.

Circuitous transportation is the result of the method of sharing the inter-line revenue on freight. Where it is necessary to share the traffic with other railroads, by routing over their lines, the revenue is shared on the basis of the percentage of the total miles each railroad hauled the freight. Where the freight charges on a given tonnage of coal to be transported between two given points are fixed, and when the transportation involves the use of two or more railroads, each railroad will cover as many miles as it can in order to increase its percentage of the revenue. Therefore, if two companies parallel each others' right-of-way for part of the distance, and it is necessary to use the parallel property in order to land the freight at its destination, the company receiving the shipment first will carry it as far as possible, even to the extent of going many miles beyond the destination, rather than give the freight to the other company at the nearest junction point. Any practice of such a nature is wanton waste. The Transportation Act of 1920 was intended to eliminate this practice by permitting combinations between railroads. The Act provided, however, that the combinations must be carried out in such a way that there would be competition. It was necessary, therefore, for the stronger roads to combine with weaker ones and the stronger companies were





Not at all receptive to the idea. There was no objection to combining with a company of equal or greater strength, but the weaker companies were not acceptable. Consequently, the combinations permitted by the Act were not carried through with the vigor that was expected, and circuitous routing of freight still exists. Under the plan of combinations, the costs would be reduced by the resulting expediency of making the most economical use of all the facilities in the combined systems. Circuitous routing of freight has not been eliminated in spite of whatever pressure has been exerted by the Interstate Commerce Commission. The companies always manage to present an excuse that is technically acceptable.





RELATIONSHIP OF INTERNAL CONDITIONS OF THE INDUSTRY TO THE  
ECONOMIC FUTURE OF BITUMINOUS COAL

Internal industrial conditions have a very definite bearing on the economic future of the Bituminous Coal industry. These conditions have created the major problems under which the industry is now struggling. And its future is completely dependent upon the solution of these present problems, for they are fundamental. They go to the very root. They must be solved either by design or by economic pressure, and they will be solved, for the nation must depend upon Bituminous coal as a future source of energy. The way in which solution is brought about is highly important to that industry's future, for whether or not the industry will maintain in the future its entity or lose its identity as an economic unit depends upon where, when and how the problems are solved. Two things are certain; that the future energy requirements of industry must largely depend upon coal, and that there is sufficient coal to satisfy all the needs of industry for many generations to come. But whether the Bituminous coal industry as an entity will provide the coal to future generations, or whether large consumers will acquire mines and provide themselves with coal, depends upon the solution of the problems. The idea that such a gigantic unit as the Bituminous coal industry could lose its identity has factual foundation. Some of the larger railroads as well as some of the important steel manufacturers have already pur-





chased mines in order that they might be assured of an adequate supply of coal at all times and at a lower cost than prevails at present. Such a tendency is an indication of what might happen generally, and it is a warning that if the Bituminous coal industry fails to live up to the demands upon it, it must yield its economic position.

The organization of the industry must be greatly altered, or more truthfully stated, there must be organization in the future where there is none today in order to make possible future success. Any economic unit giving such vital service to so greatly diversified industries and serving such a wide area as does the Bituminous coal industry, should be completely and effectively organized in all of its phases. Organization is equally vital to those whom it serves and to the coal industry itself. It would go far toward untangling the many difficulties so costly to the industry at present.

The facilities for making available the supply are more than sufficient and lend a ray of hope to this industry's future. But the fact that they are more than sufficient creates one of the present problems. The fact that the industry is capable of satisfying any demand of volume that might develop is a major point in favor of future possibilities of industrial development. From the angle of facilities for making available future supply, the coal industry is in a strategic position. The joker in the situation is that the





very ability to handle a demand of any size at present means over-production and idle capital. Better organization and foresight would have prevented such a situation. There is no reason for the industry to be able to produce a billion tons of coal a year when the average annual consumption is a half-billion tons.

The labor situation presents no great problem to future advancement. It does present a labor problem to the country as a whole, however, because the use of 200,000 men more than are needed in any industry can mean nothing but unemployment for the excess labor. At some future time the national industrial structure will have to find a place for the labor of these men. We can hope that the economic activity of the country at large will be such that these men will be badly needed. But that problem is not one affecting solely the coal industry.

As said before, the excess productive capacity is a severe problem which will greatly affect the future of the industry. It means that there is much idle capital which does nothing but hamper the industry. There are millions of ill-spent dollars serving no one and harming many. Where there is the capacity to produce, there is also the temptation. The result is chronic over-production which prevents any member of the industry making the most economical use of his facilities. Idle capital increases the burden which must be borne by the coal that is sold, and therefore, by





the consumer. Much of this capital is in mine property and is available for future use. In this sense it is not a total economic loss, but it is an economic waste for it is not producing and not adding to the economic wealth of the nation. Too much of this capital is a total loss. It represents equipment that is not producing but that is depreciating. Much of it is already obsolete and still more will become so before it has a chance to refund the investment which it stands for. The purchase of equipment without regard for its ability to perform its work, or without thought regarding the extent to which it can be adjusted to the other equipment in the mine accounts for much of the wasted capital.

There will be an answer to the questions about the place of this excess capital in the future of the industry, and that answer will be the taking of the loss by the investors.<sup>1</sup> Mines cannot operate forever without making a profit. And when there are so many of them producing that most of them incur a loss, eventual bankruptcy is the only alternative. The stronger and better equipped mines will survive. They will be able to produce at low costs and give the consumers coal at a lower price. The inefficient producers will gradually go into bankruptcy and out of production. The ill-advised expenditures will finally cease to plague the industry with too much coal. Doubtless this liquidation will be a gradual process, and it is well that it should be so for the gradation will render it a less painful process. As the de-

<sup>1</sup>-See notes at the end of this section.





mands of industry for cheaper coal become more insistent, those able to satisfy the demands will get the business. At first, only the least efficient will succumb. This will somewhat alleviate the stress, and, for a while the remaining mines will share the business, but before long the more efficient ones will strive to increase their sales by lowering the price. Following this, more mines will close. The process will continue until only the most efficient remain. A question might be asked to the effect that when only the more efficient mines are in operation and the annual production is reduced to a point closely approximating consumption, what will prevent them from again increasing the price and thereby inviting other mines into production? Also, why cannot all mines become fully as efficient as the best with the effect of increasing rather than decreasing the output?

The answer is that competition between the remaining mines will be too great to permit price increases above a normal profit. The surviving mines will have to make their profit through increased efficiency and lower operating costs rather than through increases in price. It is most unlikely that enough mines will be eliminated in the process to bring about a coal shortage. As consumption more nearly approximates production, more mines will be able to operate to capacity and reduce the overhead charges per ton. An equilibrium between production costs and market price will be reached<sup>1</sup> which will set the standard of operating efficiency.

<sup>1</sup>-See notes at the end of this section.





There are many reasons why all mines cannot become as efficient as the best. First of all, to become highly efficient, the most modern extractive methods must be applied. The application of these methods presupposes the use of costly equipment. Only the stronger mines are in a position to make the necessary purchases of equipment, and the adjustments underground that the use of the new equipment would necessitate. Changes of this nature would entail such high initial expenditures that financial strength would be a prerequisite. Lack of sufficient working capital is characteristic of the less efficient mines. It stands to reason that if they do not possess sufficient liquid funds to facilitate their day to day operations, they could not undertake any large commitments for machinery.

Many mines, because of the failure on the part of the operators to plan the progress of extraction, are not adaptable to the use of the more advanced technical developments. In some cases more modern methods could not be applied at all, and in other cases the expense would not warrant modernization. In still other mines, geological factors present an unsurmountable barrier. Geological difficulties are not a general thing, fortunately for future generations, but there are enough to make a significant reduction in output if they should be eliminated. And reduction of yearly production is vital to the future success of the industry.

Reduction in output will permit more efficient opera-

There are many reasons why all these cannot be done

as efficiently as the best. First of all, the human factor

efficiency. The most serious obstacle to the use of the

idea. The application of these methods requires the

use of costly equipment. Only the strongest nations can in a

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tion for those mines remaining in the picture. Increased efficiency implies the operation at capacity of the extractive machinery accompanied by a reduction in the price of coal at the mine. Greater efficiency will necessitate alterations in methods of production. The room and pillar method cannot survive either from the standpoint of costs or of waste. The panel system will have to be applied in the older mines. The greatest competitive advantage will belong to the newer mines in which it is not too late to plan all extractive progress and methods around the use of machinery. Here the latest technical applications of the long-wall system will yield the greatest profit.

Over-production, one of the worst ills of the industry, must come to an end. When the end will be reached is an unanswered question but it is bound to come in the not too distant future, if for no other reason than economic pressure. Because there are too many mines in operation, causing chronic over-production, over-extended productive capacity, and preventing even the best to operate most efficiently, many mines will have to be abandoned. It is only reasonable to expect this since the present productive capacity is excessive and since the application of modern technical skill coupled with detailed planning will multiply the output of a mine. It may appear contradictory to point out on the one hand that the industry is suffering from excessive capacity and then conclude that mines should be operated more efficiently with





doubled or trebled capacity, but such is the case. First, or at least in the process of bringing greater efficiency, many mines will necessarily be taken out of production for the reasons just mentioned. During the process of elimination the better mines will attain their maximum efficiency. They will satisfy industry's demand not for more coal but for cheaper coal. The abandoned mines will rest as reserves for the future. They will not resume operations until conditions of demand make it profitable to sink large amounts of new capital in them, and to spend the amounts necessary to overcome the handicaps of past mistakes. The use of specialized and costly machines, the implements of future mining, requires persistent operation at capacity if the economies made possible by them are to be realized. Their capacity operation is contingent upon the ability of demand to take up the output. That ability can exist only through the reduction of total<sup>1</sup> productive capacity.

With the use of advanced extractive methods, the greater portion of extractive waste will automatically come to an end. As a prerequisite to advanced methods, comprehensive plans of all extractive details must be made by expert technicians. The progress of the extraction will be planned in such a way that it will not be necessary to leave huge ridges of coal to support the roof. Besides this, the use of the most economical mechanical system would necessitate the application of long-wall mining, a method which allows no coal to be left underground.

1-See notes at the end of this section.





The problem of transportation has a most important bearing upon the economic future of the industry. Although it can never be eliminated entirely, the amount of transportation can be drastically modified. Unnecessary and circuitous transportation must go. If an equilibrium of productive costs is reached in all sections of the country, needless transportation will be prohibited through additions to the delivered price.

Much transportation may be done away with if coal is transformed into electrical energy at the mine mouths. Such an idea has great possibilities from a competitive point of view as well as from an economic one.

Thus the solution of the industry's internal problems will determine its future. The problems are gaining recognition and their bearing upon its future is creating concern on the part of the operators.





1 Reference to page 50.

A fair objection may be that the investor should not take the entire loss, but that there is an obligation on the part of industry and the public to share it. That the investor should take the loss is based solely on the aspect of private property, but aside from the legal angle the situation implies problems of both social and industrial nature that cannot be dismissed by a mere dogmatic statement.

2 Reference to pages 51-54

It is highly probable that some of the most efficient mines are small start or stop affairs that dig only to get their price, mines with no overhead save the labor of the owner. Such mines could continue to compete regardless of the point of efficiency attained in the large commercial mines.

Whether or not it is wise to increase productive capacity by risking investors money in high-overhead monsters depends upon the means contrived of controlling output. It is granted that huge extractive machines cannot operate economically unless they can be run at capacity, and that before they can be operated at capacity the total output must be restricted. The extent to which economic pressure can accomplish this is only a matter of conjecture. We have learned in the last few years that the direction in which the economic wind will blow does not always follow that forecast in the Old Farmers Almanac. It may well be that their only hope is in monopoly, politics and unfair legal favors. These problems are again discussed in the section on Coordination.





## RESOURCES OF BITUMINOUS COAL

## EXTENT OF KNOWN RESOURCES

The coal-bearing seams of the country contain approximately one and one-half millions of millions of tons of bituminous, entirely excluding sub-bituminous, lignite and peat. At the current rate of consumption, which ranges between four and one-half and seven hundred millions of tons a year, this supply should last for more than two thousand years. However, with the wastes which attend even the best methods of mining in practice today, the inferior quality of some coals, and the coal-consumption needed to get coal to the places where it is used, these resources may fall well within this outward limit. If, in spite of better methods of consumption, more and more coal should be consumed, this span of the life of the deposits may be materially shortened.

"But, apart from special cases, a nation prone to expect the most from discovery and think little of a morrow which is centuries off is not worried primarily<sup>1</sup> over limited coal resources."

The extent of the resources set forth herein take into consideration the average, or medium grade bituminous coal and the higher grades only. The scope of this study does not include the sub-bituminous, lignite and peat reserves which, in the aggregate are almost as extensive as bituminous.

1.

Hamilton and Wright, The Case of Bituminous Coal, p.6





Lignite is soft and dull with a claylike or woody structure. Since it has a high moisture content, it is very smoky and of inferior heating qualities. It deteriorates markedly when exposed to the elements for any great length of time, it is difficult to store and its value in proportion to its bulk prohibits transportation exceeding only the shortest distance. Lignite does have important by-product value, and, in centuries to come, it may become exceedingly important as an energy fuel.

Sub-bituminous coal is an intermediate grade between bituminous and lignite. It may be said that it neither contains all of the good qualities of ordinary bituminous, nor all of the disadvantages of lignite. It is as much trouble to mine as higher grades, and does not possess as great value, therefore, while there is plenty of the higher-grade coal available, it is not extensively mined.

The wide variation found in mineral fuels of the coal type, ranging from peat to anthracite, is not due to fundamental origin but rather to degrees of geological development. All of these carboniferous formations were originally forests of giant ferns of the ever-green variety. In the geological process of coal making, a process requiring millions of years, these forests were first inundated in swampy plains. Sediment of clay and mud gradually settled over them, new forests grew up and the process was





repeated. Terrific pressure of millions of years duration changed the organic substance into coal. It is assumed that, if left to geological forces long enough, all bituminous would become anthracite, all lignite would become bituminous, and all peat would become lignite. Unfortunately, the time that would be consumed in this process would run into so many millions of years that man could never benefit by it. If he is still worrying about coal at that remote time, his worry will not concern coal as a source of industrial power.

Strictly bituminous coal may be classified into as many types as the time and patience of the classifier permit. It may be a lustrous black or it may be dull. The range in quality extends from hard to soft. In general it has a high thermal value and burns with a medium to long flame, which gives it its great importance as a maker of steam, and gives off a generous amount of smoke.

The danger of the exhaustion of the general supply is one of the smallest worries concerning the immediate future of the industry. It should be preserved as much as possible and exploitation should be prevented, but the bituminous coal industry as such is freed for some time to come from this threat. More important is it that sooner than we expect we may be confronted with a real scarcity of high-grade steam coals, of coking coals, and of coals





adapted to fine metallurgical purposes. These supplies must be diligently guarded.

The chief difference between coals is in the percentage of carbon content, volatile matter, and inert substance. The percentage of inert matter is responsible for the proportion of ash residue. Thus, the extent of its occurrence decides in large measure the quality of the coal. Ash is practically net waste. The amount that can be realized upon it hardly pays the cost of its transportation. The value of ash as an economic good is strictly limited to its use as a filling for property. This use is decreasing rather than increasing for the largest consumers, the railroads, are showing a decided preference for crushed rock rather than cinders as a ballast for their right-of-way foundations. For all practical purposes, ash is a net loss to the user of bituminous coal.

The carbon content is the most valuable feature from a heating standpoint, for the greater the percentage of carbon contained, the more intense the heat. The volatile matter is quite an important feature for some uses. It decides the length of the flame, the amount of smoke, the kind of by-products exclusive of coke obtainable and, to some extent, contributes to the heating qualities.

In the present type of steam generation, the better steam coals are those with a high carbon content, high per-





centage of volatile matter, and, of course, low percentage of ash. In the tube type of boiler, so common in industry and almost universal in locomotives, the longer the flame the better. In this case, the volatile matter decides the range of the area that can be heated for it decides the length of the flame. Tube boilers are the most highly efficient for steam power because they permit the greatest amount of heating surface. In a locomotive the fire-box is located under the rear of the tank. The boiler tank is literally packed with tubes extending from front to rear, and spaced so that the water can settle between them. The flame is forced forward through the tubes. Here is where the volatile matter is important because it decides the amount of flame that can be so distributed. Volatile substance, which is mostly gas, is highly important as a consideration in manufacturing illuminating gas. Here the percentage of volatile matter directly determines the amount of gas that be taken from a given quantity of coal.

The percentage of carbon contained is the most important consideration when the coal is to be used for metallurgical coke. The higher the percentage of carbon, the finer the coke will be. Purity of coke facilitates the smelting and refining of all metals subjected to the coke process, and is quite influential in the determination of the quality of the product. This is especially true in the iron industry.





All bituminous coal contains carbon and volatile matter as well as ash, but the percentage of each varies widely with different types and grades. All coal will make steam, all coal will give off illuminating gas, and all can be made into coke, but the amount of coal required to make a given amount of any of these varies as well as the quality of the product sought. The high carbon coals so valuable for metallurgical purposes are not so abundant, yet they are mined steadily to be sold on the open market to any purchaser without regard for the use to which they are to be put. Depletion of that particular type would be very harmful to the iron industries, yet there is no attempt toward conservation. The use of such coal as a household fuel has even been encouraged on the sales argument that it was practically smokeless. The practice is ridiculous in the light of the fact that household heating can be accomplished just as conveniently and inexpensively with fuels of greater abundance.

High grade steam coals should be conserved for steam purposes. Although they are better than ordinary coal for making gas, the gas industry would not suffer nearly as much as railroad or ocean transportation were the supplies exhausted. The gas industry can get a given amount of gas by using more of a lower-grade coal. Locomotives and steamships would not only have to use more of a lower grade fuel for a given amount of power, but they also could not use it as





effectively.

There is, therefore, danger of the exhaustion of particular types and steps should be taken to prevent it.





## GEOGRAPHIC DISTRIBUTION

Bituminous coal underlies approximately 500,000 square miles of territory in continental United States. It is widely distributed from North to South and from East to West. The following is a list of States with bituminous coal deposits and is arranged according to the actual known tonnage contained in each State.

|               |            |
|---------------|------------|
| Wyoming       | Colorado   |
| North Dakota  | New Mexico |
| Pennsylvania  | Utah       |
| West Virginia | Montana    |
| Ohio          | Iowa       |
| Kentucky      | Oklahoma   |
| Illinois      | Texas      |
| Indiana       | Tennessee  |
| Missouri      | Washington |
| Alabama       | Michigan   |

Although Wyoming and North Dakota have the most extensive deposits, the amount mined in these states is negligible. The production centers in no way follow the order of the extent of deposits. This is true in large measure to the variation in quality and to the location of the principal centers of consumption.

The Pittsburg bed has already supplied two and one-half billion tons, and is today the most important production area in the United States. The Pittsburg area covers about 5700 square miles in Pennsylvania, West Virginia, Ohio, and Maryland. The region next in importance is the Middle





Appalachian region extending through Southern West Virginia and Kentucky. This district provides the famous Pocahontas coal so excellent for steam purposes. Third in importance is the Southern Appalachian region with its center around Birmingham. This coal is extensively used for railroad fuel and for coking purposes. The district comprising Indiana and Illinois is known as the Eastern Interior field and it is the only interior field in which coal is extensively mined.<sup>1</sup>

In general, the quality of the coal along the Eastern Seaboard is of the highest quality, and the quality becomes progressively lower from East to West. This does not mean, however, that the coal in the Western fields is of very low quality. The fact of the matter is that most of the coal in the West is of a medium grade. That in the Eastern fields is of an exceedingly high grade. For that matter, with the exception of a few fields in the British Isles and a few relatively small deposits in Germany, the coal in the Appalachian regions is the finest in the world. The coal in the Eastern interior region, though of somewhat lower quality, is able to compete with the Appalachian fields for the market of the Interior and Great Lake industrial

<sup>1</sup>

Reed, Virgil D., The Principles of Economic Geography





centers because it has a slight advantage of location. The Great Lakes transportation facilities are of the very finest. The loading and unloading facilities for coal are in many respects far in advance, at the Lake Ports, of the average Atlantic Port. Long and extensive experience in handling bulky cargoes such as grain and iron ore has done much to bring this about. As a consequence, any coal mined near a Great Lake Port has a transportation advantage over that which must be carried entirely by rail.

A major factor in the overwhelming importance of the Eastern deposits, from a production standpoint, is the location of the principal industrial centers. The greatest industrial zone in the United States is that comprising New York, New Jersey, and Lower New England. The most important coal producing area is the Pittsburgh region, the region located nearest to leading industrial center. The next important coal producing field is located a little farther from the Northern Atlantic industrial center but is nearer many smaller centers along the Atlantic Seaboard. It is probably just a fortunate coincidence that the finest coal is that which is nearest the greatest consuming areas, for in all probability, if the coal in the Eastern fields were of inferior quality to that in the Western fields, the Eastern regions would still be the leading producing areas. Transportation problems are to a very great extent more important





than the actual quality of the coal. As proof of the decisive part played by the location of the coal deposits in relation to the industrial centers, the only interior field of any importance is the one in Indiana and Illinois, located near the second ranking consumption point. In this case the coal of lesser quality can compete with the Eastern fields because it has the advantage of location.

As an illustration of the importance of location in coal production, the British Isles can be cited. The coal is of high grade but the resources are not nearly as extensive as those of Eastern United States, but Great Britain is the world leader in the exportation of coal. The finest British steam coal is mined near Liverpool, and can be shipped to almost any port cheaper than can coal from the United States. Coal from British mines is even imported by Germany, the only nation on Continental Europe with adequate coal resources, because of the relatively easy transportation between Liverpool and Hamburg. Many other instances could be pointed to to demonstrate wherein location of mines is the first consideration in deciding their importance.

Whether or not future demand will bring into prominence the vast resources of the Western fields depends first upon the location of the industrial centers in the future; and second, upon the rapidity of depletion in the Eastern fields. Although the North-Eastern section of the country is far and





away the leading industrial center, and is likely to remain so for some time to come because of its wide diversity of industry and fortunate location in relation to European centers, there is a decided tendency toward the industrialization of other sections of the United States. This tendency first manifested itself in the Southern Atlantic States. The industrial regions of Pennsylvania, Ohio, Indiana, Illinois, and Michigan, as well as the Southern Atlantic States, all depend on the coal fields now leading in production. Any new sections located at any great distance from these older centers will have a decided effect upon the importance of the Western fields. Although the Pacific North-West is forging ahead in industrial progress, the abundance of hydro-electric power has effectively averted the necessity of initiating mines in the Rocky Mountain region. But anything that would bring significant increases in population to States between the Mississippi and the Pacific coast would necessarily require industrial development, if it was only local in character. Any such development would require power which would come from the coal in that region. It is probable that if there is a significant increase in the national population, enough of it will find its way into these states to make some demand for power necessary. Even though the demand is confined to fuel for household purposes, and to public utilities, the opening of Western mines will be





warranted. Many cities in the South-West depend completely on natural gas to satisfy all domestic fuel requirements as well as the fuel requirements of the local industrial or commercial institutions. The proximity of extensive oil deposits with the accompanying natural gas plus the construction of pipe-lines through those sections has made them temporarily independent of coal. But the independence is necessarily short-lived for the oil deposits are in no way as extensive as those of bituminous coal and depletion is not to be thought of as of the distant future. The natural gas is invariably exhausted before the oil, therefore it can be expected in the near future that coal gas will replace natural gas in these areas.

Intensive mining of coal in the Western fields to substitute the resources in depleted Eastern deposits will come in the more remote future, nevertheless it will come. Although the Eastern reserves are vast, the present rate of extraction is such that exhaustion of Eastern coal beds is definitely certain unless science contrives some way of capturing power from the sun or from the ocean and is able to make it readily available for industrial purposes. No one living in this day of scientific progress would venture that any such development was impossible, but it is not sufficiently probable to be counted upon. It is far more likely that a development of that nature would come into being after the pinch of complete exhaustion





began to be felt. The much talked super-power is only in the stage of hypotheses, and although its possibilities are fully realized, it is far from available at present. What is more important, super-power is nothing but a scheme to make a ton of coal go farther. Thus, when the Eastern fields are depleted, or the industrial centers change, the Western deposits will be brought into intensive production.<sup>1</sup>

There is an exceedingly fortunate geographic distribution of bituminous coal in relation to alternative resources of power. From the standpoint of potential hydro-electric power there is very little overlapping. In the Pacific North-West, the district comprising Washington, Oregon, and Western Idaho, there is forty-one percent of the entire hydro-electric power resources of the United States. And it is notable that there is comparatively little coal in this region. The area second in the possession of potential hydro-electric power is the central Rocky Mountain district containing thirty percent of the national resources. Except in the Eastern part of this area, there is very little coal. California, with a large amount of water power has no coal. Even the Tennessee Valley power does not completely overlap the Eastern bituminous coal resources, although some of the area that this power will serve is in the coal region. Other sections of the country having coal do not have extensive water power. And most of those possessing but negligible

<sup>1</sup>-See notes on page 71





water power are located quite conveniently to coal supplies.

The oil and the coal supplies do not generally overlap either. Pennsylvania, with great supplies of both coal and oil is the one outstanding exception. Oklahoma, Texas, California, and Pennsylvania are the leading producers of petroleum. Pennsylvania, Oklahoma, and Texas have coal but Pennsylvania is the only one of these states where coal is extensively mined. Other states produce some oil, but as a rule, they produce no coal at all. California, an important oil producer has no coal at all but has a lot of hydro-electric power.

Much of the coal in the Western deposits is located between mountain ranges; a factor which hinders its accessibility. There is a greater transportation problem in carrying coal through mountainous regions than across plains, consequently coal can be transported many times as far through level country as it can through mountainous territory at equal expense. The industrial cities along the Pacific coast, those which would be users of the coal from the Western fields, are supplied with sufficient water power to take care of their present needs. Not only greater distance from the principal coal consuming centers, but also more difficult transportation counts heavily against the extensive use of the Western coals.<sup>1</sup> On the contrary side, once the transmission system for hydro-electric power has been constructed, its

<sup>1</sup>-See notes on page 71





transmission through mountainous country is about the same in cost as transmission over an equal distance of level area. As an example of the effect of this situation, Washington State has some coal deposite, but they are not worked on a commercial scale because it is less costly to utilize the water power so abundant there. The port of Seattle importe Canadian coal because it can be brought in at less cost than the coal can be transported from the Southern interior section of the state. The consumers of coal will pay the price of using that which is not easily accessible only when their need for it is great enough and when there is no alternative.

1-Reference to pages 69 and 70.

There is a large coal developement in Colorado. And some of the Wyoming coal is of better quality than Pennsylvania or Alabama steam coal. Both these states also produce oil; a very large amount if counted per capita. The text on the pages in question refers to the comparative situation concerning Eastern and Western mining operations, but these notes are necessary to prevent the impression that no coal is mined in Western fields. Kansas, also, produces a fair amount of coal and oil.





## USES OF BITUMINOUS COAL

## ANNUAL PRODUCTION

The average annual production of bituminous coal in the United States between 1923 and 1929 was 550 million tons. Since this figure is based entirely on the years previous to the depression, and since the abnormal years of 1927 through 1929 probably color this average somewhat, it would be a safer estimate to say that the normal average consumption was 500,000 tons. To take years previous to 1923 on which to compute an average would entail a greater chance for error because, although the industrial activities were increased artificially during the war, the normal business demands have generally increased since that time to an extent that would render unparallel any computations based on the earlier period. The average production during the war period, 533,644,000 tons was higher than the normal of 500,000,000 tons but it does not compare with the peak of 730,000,000 tons reached in 1928.

Strangely enough, although industrial activity increased markedly from 1922 until the depression, the bituminous coal industry went into a decline in 1924 and has been in that state ever since. This situation resulted chiefly from conditions within the industry and to a minor extent from more economic use of coal because of high prices. The annual





consumption of coal was high during this period, but would have been higher had it not been for the economies put into effect by the consumers. In order to encourage greater consumption and to seize all of the existing market possible, the individual mine operators engaged in price cutting wars, and labor bore the brunt of the price decreases. In order to demonstrate this peculiar situation of depression amid prosperity I have taken the following quotation from the Code of Fair Competition for the Bituminous Coal Industry.

"Unlike most industries, that of bituminous coal began to feel the effects of economic maladjustment in 1924. Since that time the condition of the industry has become progressively worse, notwithstanding the increasing tempo of most industries up to the summer of 1929. For the 30-year period ending in 1918, the average annual increase in the production of bituminous coal was approximately 18,000,000 tons. During the period 1918-1929 this trend of annual increase disappeared. The average for the five years, 1916-1920, was 533,000,000 tons, for 1921-1925 was 482,000,000 tons, and for 1926-1930, was 520,000,000 tons.

Since 1920 the trend of mine realization for coal has been downward. The average for the four years 1919-1922 was \$3.08. For the succeeding years the average realization was \$2.68 in 1923, \$2.04 in 1925, \$1.99 in 1927, \$1.78 in 1929, \$1.70 in 1930, \$1.54 in 1931, and \$1.27 in 1932.

consumption of coal was high during this period, but would have been higher had it not been for the economic conditions to which the country was subjected. In order to encourage greater consumption and to bring all of the existing power plants, the industrial plant operations were placed in a position where, and labor more than made up the balance. In order to demonstrate this position a list of production and consumption of coal is given in the following table from the data of the Department for the Richmond Coal Industry.

1914.

"Unlike most industries, that of Richmond coal has

been to feel the effects of economic readjustment in 1934. Since that time the condition of the industry has become progressively worse, notwithstanding the increasing tempo of most industries up to the summer of 1933. For the 30-year period ending in 1913, the average annual increase in the production of Richmond coal was approximately 14,000,000 tons. During the period 1913-1933 this trend of annual increase disappeared. The average for the five years, 1918-1922, was 285,000,000 tons; for 1923-1927 was 282,000,000 tons; and for 1928-1932 was 280,000,000 tons. Since 1933 the trend of mine production has been downward. The average for the four years 1931-1934 was 270,000,000 tons. For the succeeding years the average production was 260,000,000 in 1935, 250,000,000 in 1936, 240,000,000 in 1937, 230,000,000 in 1938, 220,000,000 in 1939, 210,000,000 in 1940, 200,000,000 in 1941, and 190,000,000 in 1942.



"With the wage bill constituting 60-65 percent of the total cost of production and wages practically the only flexible item in costs, the result has been that the burden of declining prices has fallen in greatest force on the wage earners. Thus the coal industry was an economic "sore-spot" for at least five years before 1929.

"Not only did labor suffer during this period but many mining operations were forced into receivership and reorganization and earnings were far from adequate on the investment in the industry. In 1929, a year of high production, corporations in the industry reported a net loss of \$11,300,000. The reported net loss for 1930 was \$42,071,000. Similar data for other years are not available.

"The condition of the industry was particularly acute in 1931, 1932, and first five months of 1933. Beginning in June, considerable improvement in production has taken place and since the first of July the output has exceeded the corresponding period of 1931, although still remaining considerably below normal and about 26.5 percent below the production during the corresponding period in 1929."

The answer to the situation described in the Code is too many mines; staggering excess of productive capacity. It is only natural to expect that a primary industry such as this one would feel keenly the results of decreasing activity in industry of the productive type, but when such an industry





declines when there is a step-up in the demand for its product, the only answer can be found in conditions within the industry itself. Over capitalization means failure to make profits, and, in turn, the liquidation of the assets whenever the situation is acute. In another section the future prospects of the less efficient mines were discussed. The idea advanced was to the effect that the mechanization of the more efficient mines would force out the marginal producers, because they lack sufficient capital to put into practice the advanced methods permitted by present technical development. Even before such a trend could gain headway, economic factors have been forcing many mines out of the picture. The productive capacity had to be cut down for sheer weight of its own capital structure. The following list of closed mines illustrates the effect of economic pressure on the industry.

1

(capacity, tons)

|                                   |              |
|-----------------------------------|--------------|
| 219 had been idle since 1923..... | 17, 000, 000 |
| 118 had been idle since 1924..... | 19, 000, 000 |
| 83 had been idle since 1925.....  | 13, 000, 000 |
| 151 had been idle since 1926..... | 12, 000, 000 |
| 313 had been idle since 1927..... | 42, 000, 000 |
| 210 had been idle since 1928..... | 27, 000, 000 |
| 261 had been idle since 1929..... | 30, 000, 000 |

Most of these closed mines could resume operations if the price was high enough to warrant putting more capital into them, and not counting this number, 1355, of closed





mines, 5642 mines of commercial size produced in 1932.

The United States is by far the world leader in the production of bituminous coal. The United Kingdom is the leading exporter of coal. Until about 1880 England was the leading producer but yielded first place to the United States at that time. The average annual production of Great Britain is 250,000,000 tons, the normal average for the world is approximately 1,000,000,000 tons. Thus the United States contributes about fifty percent, Great Britain contributes about twenty-five percent, and all other nations make up the remaining twenty-five percent of the world's production. The fly-in-the-ointment is the fact that the United States stands ready at present to produce an amount equal to the entire world consumption while the export trade amounts to only one-tenth of the country's annual production.





## INDUSTRIAL POWER

Thirty percent of the annual production of bituminous coal is required to satisfy the needs of industrial power. Electric utilities consume about ten percent of the annual production, so, after deductions are made for municipal and domestic lighting, it is apparent that there is not much of this amount available for industrial power. Generally, large industrial enterprises have found it to be advantageous to maintain their own power plants.

The use of direct steam power for industrial purposes is rapidly fading from sight. It was not until Michael Faraday made his revolutionary discovery, some seventy years ago, that it was possible to use the energy contained in coal in any other way than by direct steam power. The perfection of the electric generator made slow progress and it was not until about thirty years ago that sufficient electric energy could be generated to serve industrial requirements. Within the last two decades the use of steam power directly has been yielding until it now holds a very minor position. Direct steam power is very inefficient because there is heavy loss through friction, belting and shafting, and it can be transmitted in no other way than by means of belts and shafts. Electric energy has greater mobility as well as greater economy. All that is necessary to transmit it from one building to another





is to make the necessary connections by means of wire conductors.

In order to transform coal into electrical energy several steps are necessary. The coal has to be burned and turned into heat, the heat must transform water into steam, the steam must be made into mechanical energy, and the mechanical energy is turned into electrical energy. The first two steps simply require the burning of coal to boil the water. Turning steam into mechanical energy requires the use of a steam engine. The most efficient is the steam turbine which has been developed to a high degree. The turbines turn huge generators which make electricity. In this form the energy derived from coal can be made available at any point in the plant where it may be needed. Since power is required in practically all manufacturing operations, coal has become the mainstay of industry. The use of machinery implies the use of power and the use of power implies the consumption of coal in the most cases. Industry and coal are mutually dependent, for each without the other would be very much handicapped. Broadly speaking, where there is increased industrial activity there will be more consumption of coal because no other resource can supply the demand for industrial power.





## LOCOMOTION AND TRANSPORTATION

Twenty-five percent of the annual production of bituminous coal is burned in locomotives, and five percent is used for ocean transportation. Since American-owned vessels are not a prominent factor in world trade, a very minor portion of our annual production is used in steamships.

The steam locomotive is by far the most important carrier in the United States. They haul seventy-six percent of all the freight moved in the United States including that transported via the Great Lakes, the inland waterways, and the pipe-lines. They will continue to be the back bone of our overland transportation system, and what is more, they will continue to depend on coal as the source of their power. Petroleum is not a threatening factor to the use of coal in locomotives, and hydro-electric power has even less chance to supplant coal on the railroads. In the first place a very small percentage of American railroad lines is electrified, and it is not likely that electrification will progress very rapidly, if at all, because of the tremendous expense involved. Electrification of its mountain division caused the Chicago, Milwaukee, and St. Paul Railroad to go into receivership. In the second place, hydro-electric power cannot compete with bituminous coal in supplying locomotive energy because most of it is





located in sections of the country where the movement of freight is small in volume. The location of the principal industrial centers decides the direction of freight movements, and these are beyond the reach of the most extensive hydro-electric power resources.

It is true that the locomotives are of the least efficient mediums for extracting the energy from coal. They actually use only from ten to twenty percent of the potential power. The reason for this inefficiency is that they have to consume raw coal and cannot be hampered by the equipment necessary to do even this most efficiently. The greatest dissipation of power comes through loss of heat by radiation and convection, and this cannot be readily controlled on a vehicle moving at high speed. The most effective way to use all the power in coal would be through complete electrification of the railroads. But it would entail such staggering expense that it is beyond practical application at the present time.

Great strides have been made in recent years toward increasing the efficiency of locomotives, and today they are as much as one-hundred percent more efficient than they were in the past.

The increased use of American coal for ocean transportation depends upon the building up of the American Merchant





Marine, and to some extent upon our increased prominence as an exporting nation. If the export trade of the country increases, there will be greater demand for coal at American bunkers. There are possibilities along this line, but the immediate future is none too promising.





### BY-PRODUCTS

Besides its energy potentialities, bituminous coal possesses tremendous value in its by-products. One ton of medium grade coal contains 10,000 cubic feet of gas, 1,500 pounds of smokeless fuel, 22 pounds of ammonium sulphate, 2.5 gallons of benzol, and 9 gallons of tar.<sup>1</sup> This classification is a broad one for each of these products can be broken down into many other commodities.

Unfortunately full advantage of the by-product possibilities in bituminous is far from realized. Most of them are consumed in the raw state with the result that many of the by-products are lost, for they all cannot be transformed into energy. Most of the gas is consumed, and most of the solid fuel and benzol, but the tar and ammonium sulphate is dissipated into the air as smoke. The difficulty lies in the fact that each consumer is interested in but one use, or one product of coal. Industry and railroads want power and when it is taken by present methods, the by-products are lost. The gas companies were the first to try to use the by-products. They had the advantage in that they were about the only consumers with whom there were any by-products remaining after the coal had served its primary

1. Gilbert, C. G., and Pogue, J. E., The Energy Resources of the U. S., United States National Museum, Bulletin 102, p.11.





purpose. They were primarily interested in the gas content, but after they had taken the gas, they had a lot of coke and messy tar on their hands and had to look for some way to get rid of it, at a profit if possible. From this point, chemists started to work and discovered plenty of uses for what was left.

The following lists represent the commodities that can be obtained from each of the principle by-products of bituminous coal and a general explanation of their use.

Gas may be divided into gas and gas liquor.

1

Gas contains:

|                 |                  |
|-----------------|------------------|
| Carbon Bisulfid | Sulphur          |
| Benzol          | Cyanogen         |
| Toluol          | Illuminating Gas |
| Xylol           | Fuel Gas.        |

Carbon bisulfid, toluol, xylol, sulphur and cyanogen are used for chemical purposes. Benzol is used as a motor fuel and a solvent. Illuminating gas is used for household fuel purposes and fuel gas is used as industrial fuel.

Gas liquor chiefly contains ammonium compounds which are used as fertilizers, chemicals, and refrigerants.

Coke is used as metallurgical coke, domestic fuel, oven carbon, and as a base for the manufacture of graphite. Oven carbon is made into electrodes and lamp-black. Graphite is the base of a lubricant, lead pencils, crucibles, and electrodes.

Coal tar derivatives come under three major classi-





fications, each of which has many sub-classifications. Each of these major classifications is presented individually with its derived products.

Light oil contains: <sup>1</sup>

|                    |                 |
|--------------------|-----------------|
| Crude Benzol       | Anilin          |
| Pyridin            | Cresols         |
| Solvent Naphtha    | Sulphur Acids   |
| Heavy Naphtha      | Carbon Bisulfid |
| Crude Carbohc Acid | Acetanilid      |
| Crude Toluol       | Benzoic Acid.   |

When these derivatives are refined they are employed as motor fuel, chemicals, denaturants, solvents, dyestuffs, explosives, medicines, varnishes, disinfectants, flavorings, food preservatives, and perfumes.

Middle oil contains: <sup>1</sup>

|                    |                |
|--------------------|----------------|
| Crude Carbohc Acid | Phenol         |
| Neutral Oils       | Cresol         |
| Lamp Black         | Sulpho Acids   |
| Crude Naphthalin   | Phthalic Acid. |

When these derivatives are refined they are used in paint thinners, shingle stains, insecticides, dyestuffs, synthetic resins, synthetic plastics, explosives, aspirin, flavorings, and many chemical compounds.

Heavy oil contains crude carbohc acid, anthracine oil, and lamp black. These are used in wood preservation, pressure impregnation, disinfectants, lubricating greases, and dyestuffs. <sup>1</sup>

Refined tar is used in paints, tarred felt, pipe coating, sub-flooring, sidewalk composition, paving materials,

1. U. S. National Museum Bulletin 102, plate 2.





composition shingles, specification roofing, ready roofing, insulation, and water-proofing.

Soft pitch is employed as insulation, water-proofing, and paving filler.

Medium pitch is used in the manufacture of briquets, paints, roofing, and water-proofing compounds.

From hard pitch can be manufactured briquets, core compoundings for metal casting, electrode carbons, targets, powdered fuel, and pitch coke.<sup>1</sup>

Most of the by-products of bituminous coal, and especially those classified as "chemicals" have many uses as raw materials in products not named in the above lists. These lists are broad classifications, and each of the individual items has many industrial values. The uses and products in which coal-tar derivatives figure are practically innumerable. No definite dollar value can be placed on any one of the items because in the process of manufacture varying amounts of value are added to each, and the necessity for one product in one case may far outweigh the necessity for the same product elsewhere.

The gas industry consists of a great number of separate plants, distributed, one or more each, among the cities of the country. These plants consume in the aggregate about five percent of the annual coal production of the United States. Since their prime purpose is to manufacture gas,

1. The lists of uses of coal by-products were taken from U.S. National Museum Bulletin 102, Vol. 1, plate 2.





this they do without adequate regard to the complete recovery of by-products, although many plants make a partial recovery of ammonia and tar, and some gas-house coke is put on the market. The gas companies are public utilities with monopoly privileges and controlled prices, consequently there is not much incentive for advances in technical procedure. Nowhere is there full by-product recovery, and the price of gas is uniformly high. The gas company is an established business, which can be converted into an organization that will supply all the fuel, whether gaseous or solid, that the community needs. For the relative neglect of the present can be substituted a by-product system of coal distillation, producing artificial anthracite, gas, ammonia, benzol and tar, and a centralized distribution of products. The output will be limited at first by the demand for solid fuel. The output of ample solid fuel will give an excess of gas over that now produced, which will encourage an expansion in the use of gas both in the home and in industry, such expansion will come as a result of cheaper gas, incidental to the proposed plan of production.

Gaseous fuel is bound to increase in importance, compared to solid fuel, especially in the industries. While solid fuel can be converted into power only by means of the steam engine, gas may be used in the internal combustion engine, which for the same equivalent consumption delivers in general over twice the power. For purposes of heat produc-





tion, gas presents an ease of control and a mobility of application that place it beyond comparison. The use of gas is in a relatively undeveloped state. Adaptation of the internal combustion engine, the gas turbine, the utilization of gas under pressure, and the application of the surface method of combustion offer lines of advance that will add a growing weight of superiority to the use of gas. For industrial purposes, gas offers conspicuous advantages, as evidence by the varied industrial use of natural gas in all regions where abundance of supply creates a low price.<sup>1</sup>

Coke has its greatest importance in its use for metallurgical purposes. Between twenty-five and thirty percent of the bituminous coal mined in the United States is used for metallurgical coke.<sup>2</sup>

Coke is made by heating certain classes of bituminous coal at high temperatures, with the production of a hard, porous residue, composed essentially of carbon. Two methods of manufacture are in general commercial use. One employs beehive ovens; the other makes use of retort ovens, which are usually long and narrow and assembled in batteries. The latter are appropriately termed by-product ovens.

1. Gilbert and Pogue, U.S. National Museum Bulletin 102. Vol. 1, p.p. 17-18.
2. Minerals Yearbook 1932-33, p 395.





The beehive oven delivers a product well suited to metallurgical use, but the process is objectionable because of the waste involved. It not only fails to yield the maximum of coke, but it effects no recovery of other valuable constituents. The products lost represent a measurable waste in terms of dollars, but they carry greater significance as being the raw materials upon which could be built an adequate manufacture of fertilizers, dyes, drugs, and explosives.

The by-product oven receives raw bituminous coal and subjects it to destructive distillation. This process consumes none of the coal, but breaks it up into five components; coke, gas, ammonia, benzol, and tar. Coke is the main product while the other four constitute by-products. About half of the gas produced is used to supply the heat essential to the operation; the by-products are partly or wholly recovered according to the details of the practice. Where the by-products are wholly recovered, no part of the coal is wasted. These products have an unlimited field of usefulness as such. In addition, three of them represent raw materials upon which important fields of present industry are dependent and upon which, if the supply is sufficient, new industries can be built.<sup>1</sup>

Coke, being designed for metallurgical purposes, is not the best fuel. But it has inestimable value in the iron

1. U. S. National Museum Bulletin 102, Vol.1, p. 13.





and steel industries. The fact that such a large percentage of the annual production is used for metallurgical purposes is sufficient evidence. Any products that could take the place of coke in this use are but poor substitutes at best. It may be said then that since coke is one of the basic raw materials of the largest industry in the country, it is a primary commodity.

Benzol, in its refined state, is a hydro-carbon of many uses. It rivals gasoline as a fuel for internal combustion engines, it is an excellent solvent, and it combines well in chemical compounds. It is a mixture of substances, including the powerful toluol, which can be made to yield explosives, dyes, drugs, medicines, solvents, photographic developers, and other chemicals. The most formidable of the explosives manufactured from benzol is tri-nitro toluol, commonly called T. N. T. Aspirin and iodine are coal tar derivatives. It is an odd coincidence that one resource yields both the explosives that cause injury and the medicines that relieve it.

Each ton of medium grade bituminous coal contains about two and one-half gallons of benzol. Its price varies between fifteen and twenty-five cents per gallon, depending upon the demand and supply relationship. The quantity produced could be increased several times its present volume, but the demand does not warrant any great increase. The present situation makes benzol a by-product of other pro-





cesses, and not one particularly sought for itself. Although there is a constant demand for benzol, it is not sufficient to take up all of the production. So far the case has been one of finding a market for that produced as a by-product rather than one of producing intentionally for a well defined demand.

Ammonium sulphate is used extensively as a fertilizer. Each ton of bituminous coal contains about twenty-two pounds of ammonium sulphate and it sells for about two cents a pound. Most of it is recovered in this state, but the ammonia recovered as such, instead in the form of ammonium sulphate, forms the basis of modern refrigeration and is used for making explosives and chemicals.<sup>1</sup>

The uses of coal tar have been set forth, in the major divisions, in the preceeding list. The industrial possibilities of this product are too numerous to describe here. One ton of bituminous coal contains approximately nine gallons of tar which sells for less than five cents per gallon. The price is nominal compared to the potential value. It has extensive use as such, but also yields about a ten percent fraction which may be turned into explosives, disinfectants, dyes, drugs, and other products. Benzol and tar, in short, are the basis of the coal tar industry, as yet inadequately developed in the United States.<sup>1</sup>

1. U. S. National Museum Bulletin 102 Vol 1, p. 13.





### FUTURE IMPORTANCE OF BY-PRODUCTS

The importance of bituminous coal for the sake of its by-products is evident in the fact that between twenty-five and thirty percent of the annual production is used for this purpose. Important though by-products are at present, they are bound to become increasingly so in the future. The only drawback is lack of comprehensive industrial development along that line. This slow progress is the result of a number of factors which are slowly being overcome. The by-product oven is complicated, costly to operate, and costs about a million dollars to install.<sup>1</sup> Like the beehive oven, its prime purpose is to deliver coke, but it can compete with the beehive oven only when the by-products can be disposed of with sufficient advantage to cover the greater expense of the by-product practice and allow a margin of profit. The development of by-product coking in the United States has been slow, considering the social and national importance of the possibilities in this activity. Although the beehive oven is still turning out much of the coke produced there is a decided trend toward the use of by-product coking. The reason for slow growth of this practice is that there has not been sufficient demand for all five of the products, due to inadequate industrial utilization of gas, and practical lack of a coal tar industry.<sup>2</sup> Also the apparent

1. U. S. National Museum Bulletin 102, Vol. 1, p. 14.

2. Ibid.





abundance of gasoline has put no demand upon benzol as a motor fuel. There has been a stable demand for only two of the products, coke and ammonia. The gas had a varying value from a product representing the chief source of revenue in some instances down to one giving returns too small to justify its storage. The municipal gas plant is an example of the former instance and the metallurgical coke industry is an example of the latter. Until recently, benzol was not even recovered, so lacking was the demand for it. And benzol contains toluol, upon an adequate supply of which modern warfare is absolutely dependent.<sup>1</sup>

To build a proper coal-products industry, even within the limits set by the coke needs of the iron industry, will require the establishment of a steady demand for the four by-products; gas, ammonia, benzol and tar; a demand which will give them a commercial value in keeping with their real worth. This, in turn, will depend upon an enlarged utilization of gas for fuel purposes, and the growth of a substantial coal tar industry, an industry upon which many others at present utterly depend. As stated above, there is a decided trend toward the intensive use of by-products. This trend is certain to gain increasing momentum in the near future. The coal tar industry has too many possibilities to be overlooked, especially in a country that is looking for a

1. U. S. National Museum Bulletin 102, Vol. 1, p. 15.





means to employ surplus labor and a fabulous amount of idle capital.





### Heating

At present, heating is one of the minor uses of bituminous coal. A small amount is used for domestic heating purposes, but since most homes are equipped to consume coal in the raw state, bituminous coal is objectionable because of its smokey combustion. Coke is extensively used for this purpose in cities equipped with gas plants but the amount of coke consumed in this way represents but a negligible fraction of the annual production of coke, not to mention bituminous coal. Gas is usually consumed as domestic fuel, but it is primarily employed in cooking. Anthracite<sup>1</sup> enjoys the larger portion of the domestic heating market. There is a trend away from anthracite and toward petroleum. This is actually necessary for the resources of anthracite are dangerously near exhaustion. The trend toward petroleum can be but short-lived however, for the petroleum resources are in practically the same position as those of anthracite. This means that in the not too distant future, bituminous coal must satisfy all the requirements for domestic fuel. Probably the future domestic heating will be gas heating. Already the gas utilities in the larger metropolitan areas have entered the domestic heating field and have succeeded in supplying it at a price which enabled them to make rapid progress.

Most industrial buildings are heated by the same source from which they derive their power. This means that bituminous coal supplies the heat in the majority of in-

1-Note on p.95





stances. It is a simple matter to utilize the exhaust steam from the power plant.

Commercial and public building are, as a rule, heated by bituminous coal. In the larger metropolitan areas, there are central steam generating plants with pipe systems carrying mobile heat to any building that is in a location near enough to receive it. As a matter of fact, the exhaust steam from the central electric power station is often distributed for heating purposes. Where there are no central steam generating plants, mercantile and public buildings are generally heated by burning bituminous coal in the raw state. Because the heat in public and industrial buildings is supplied, in the larger cities, as a by-product of the power industry, it is impossible to state an approximate percentage of bituminous coal used in this way.

It is reasonably certain that public and commercial buildings, as well as residences, will have to be heated directly or indirectly through the medium of bituminous coal.

1-Reference to P.94

Anthracite is little used outside New England. Wood and bituminous coal serve the household heating requirements in other sections of the country where household heating is necessary. However, if bituminous were substituted for all the Anthracite now used, the annual consumption of bituminous would be increased by 100,000,000 tons.





FUTURE PROBABILITIES IN RELATION TO USES OF BITUMINOUS COAL

Industrial power, in the future as today, will have to be supplied chiefly by bituminous coal. Hydro-electric power can and will be used wherever practicable, but because of limitations upon the amount available, upon the distance that it can be transported, and because of the adverse relationship between the location of the sources of the hydro-electric power and the principle industrial centers, it cannot make severe inroads upon the demand for coal.

Locomotion and transportation must continue to depend on bituminous coal as its chief source of power. Petroleum offers only a temporary threat and a weak one at that. Hydro-electric power is not a dangerous rival because of its poor distribution and because of the fact that electrification of railroads is too costly an undertaking to be considered in the near future and even though electrification became common, coal would generate most of the power. As in the case of railroads, petroleum is only a temporary threat to coal in coming for utilization in ocean transportation, and, of course, the use of hydro-electric power for this purpose is technically impossible.

The intensive utilization of by-products offers great promise for expansion in the coal industry. Although such a development is contingent upon the development of other industries, and upon increasing demand for the by-products, it is quite possible that this development will





reach such a stage that the municipal gas and metallurgical coke industries will not be sufficient to supply the raw materials for the new industries.

Gas has a bright appearing future in the field of domestic heating, and, to some extent, in the field of industrial power. It has already made a start in that direction, and the promise of gas at a lower price bids fair to keep it going.

Increased use of coke depends in large measure on expansion in the iron and related industries. It is more than likely that expansion in that field will continue. There is no indication that the present demand for ferrous products will decrease, and there is considerable likelihood that new industries will make demands upon it. Witness the metal ships, the steel framed buildings, and the automobiles; all fairly recent uses of iron. These industries are still progressing, and almost daily some new machine comes into the picture to use iron in its application and in its own construction.

Ammonium will enjoy increasing demand in chemical application as well as in fertilizer. The possibility of lower costs will make it applicable to an increasing number of processes. It is relatively inexpensive today, but decreased cost will encourage experimentation with the view of substituting ammonium in processes where other compounds are used.





Benzol is likely to be subject to a very persistent increase in demand because of its value as a motor fuel. Since it is an effective solvent it can be profitably used in the cleansing and dyeing industries which are becoming rather important. Any significant increase in the demand for explosives, chemicals, or hydro-carbons is almost sure to effect benzol.

Coal tar is but waiting for a demand that is lazily but surely approaching. Because it has diversified value for chemical application, it will gain more prominence as the use of chemicals advances. Because it is a valuable product in the building industry, it can be expected to enjoy increased consumption with resumption of building activity. Because it can serve well as paving material, it has promise in that direction.

There is little danger of bituminous coal losing ground as a supplier of heat, and the future offers possibilities of increased use.

Thus, the future probabilities in relation to the present uses of bituminous coal point to gains in practically all phases of its application. There is also likelihood of new industries entering the field to make demands on coal for power and for by-products.





COMPETITORS OF BITUMINOUS COAL  
HYDRO-ELECTRIC POWER  
- - - - -

Hydro-electric power is the only inexhaustible energy resource known. Attempts have been made to harness wind power, but, because of independability in strength and occurrence, wind has been proven to be impractical for commercial needs. Because water power is, for all practical purposes, inexhaustible, it should be developed to the maximum of practicability.

There are several factors placing limitations on the value of a given stream as a source of water power.

These are:-

1. Length of stream. The longer the stream the less it is affected by local seasonal and weather variations.
2. The annual flow of the stream.
3. Seasonal variations.
4. The fall or "head" obtainable at the power station.
5. Ice conditions.
6. Sediment conditions.
7. The distance that power must be transported to consumers.
8. The demand for power within a reasonable distance.
9. The availability of other sources of power, such as coal and petroleum.<sup>1</sup>

I - These factors taken from Reed, Virgil D., Principles of Economic Geography, p. 105.





The total hydro-electric power resources in the United States, if completely developed, could supply approximately forty-eight percent of the normal industrial requirements. Much of this power is either unfavorably located in relation to accessibility or insufficient in a given place to warrant intensive development. Edison is accredited with the statement that if every raindrop and every snowflake that falls in the United States could be harnessed, the resultant power would still fall far short of satisfying industrial requirements.

Although the geographic distribution of hydro-electric power is fortunate in relation to the distribution of other energy resources, its distribution is adverse in relation to the principal power consuming centers. Forty-one percent is concentrated in the Pacific Northwestern States, thirty percent is in the Central and Southern Rocky Mountain area, and the remaining twenty-nine percent is distributed in small amounts throughout the rest of the country. The most significant concentration in the East is in the Tennessee Valley district. In many cases the widely scattered small percentages of potential water power do not hold much promise for future development, but in a few instances such power is quite important. An example of such an instance is the development at Keokuk, Iowa where a very short fall in the Mississippi was cleverly harnessed and made to yield the utmost of its potentialities.





About thirty-seven percent of the water power resources in the United States are now developed. The intensity of this development closely correlates with the extent of industrial enterprise in a given area. In Massachusetts, where industrial activity is concentrated in relation to its size, approximately ninety percent of the water power is developed.

Although once developed the actual energy giving source in hydro-electric power costs nothing, and granted that water power should be developed wherever practical, the final cost to the consumer cannot be much less than that of steam generation. This is true because over two-thirds of the total cost of power is chargeable to transmission and only about a third to generation. This does not mean that hydro-electric power is only two-thirds as costly as steam generation, for generation includes the cost of the plant in depreciation, operation, and interest on capital investment. Uniformly hydro-electric plants are more costly to install than those employing steam; the result is a larger capital investment and heavier interest burden. Besides this aspect, a hydro-electric plant must base its capacity on the lowest water level. Consequently, in calculating the peak capacity of a plant, the lowest seasonal flow must be used as a base. In most cases, in order to meet peak demands at times of low water, hydro-electric plants have auxiliary steam plants. In some





parts of the country, auxiliary steam plants are an absolute necessity because of the constant danger of drouth. The necessity for auxiliary steam plants increases the overhead burden when they do not operate because they represent idle capital; not to mention that they use coal when they do operate. Professor David F. Jordan claims that from an investor's standpoint, it makes little difference whether steam or hydro-electric generation is employed.

Electric energy can be transmitted economically for a distance not exceeding 250 miles.<sup>1</sup> The cumulative resistance in the conductors as well as leakage would necessitate the generation of so much more power at the source than could be made available at the point of consumption, that transmission over greater distance would cost more than the operation of a plant nearer the market. As a result, though there may be an excess of hydro-electric power in one area, and a marked shortage in another, it might easily be more economical to erect a steam generation plant than to transmit the hydro-electric power from the area of surplus. This is the principal reason why such a large percentage of the water power resources remain undeveloped.

Hydro-electric generation cannot seriously affect the demand for bituminous coal - first, because there is not sufficient available to satisfy more than half of the present demand for energy - second, because its location

<sup>1</sup> See note on page 104





is such that much of it cannot be economically transmitted to the major industries - third, nearly two-fifths is now in use - and fourth, nearly one-third of the bituminous coal is used primarily for its by-products rather than for energy.

Doubtless hydro-electric power, if more thoroughly developed, will take some of the future demand that would otherwise go to bituminous coal. This is not a threat to the future expansion of the coal industry. It is very improbable that water power made available in the future would draw a significant amount of the industry away from the coal power areas because the difference in the cost of the power is not sufficient incentive. The heaviest industry, iron and steel mining and manufacturing, must remain near the iron mines, and as near as possible to the coal mines, for it uses most of the coal as coke. Other industries using bulky raw materials are at present located as advantageously as possible, and a slight decrease in the cost of power elsewhere would not pay them to move. As a result, future expansion in the use of hydro-electric power will depend upon the building up of new industries. Any progress along such a line depends upon more intensive industrialization and increased population. If any such development materializes, the new industries will have to depend on both the iron and steel industries, and on the coal-tar industry





for raw materials. The consequence would necessarily be an increase in the demand for coal.

There is little probability that the railroads will become electrified to any great extent. Most of them are struggling under a much too heavy funded debt at present, and electrification would tremendously aggravate the debt situation. And if they did electrify, they could not draw heavily upon hydro-electric power because of the limits upon the distance of economical transmission. The western extremity of the Great Northern Railroad is in an area of abundant water power, but this could be effectively used over only a tenth of its main line track. This is an example of one that runs through the greatest water power region of the country, but all except a very small portion of the freight is hauled through country where there is practically no hydro-electric power available.

1-Reference to page 102.

According to late news notes, the General Electric Company has developed a transmitter reputed to be effective for a distance of 1000 miles. Such a transmitter would increase the utility of the hydro-dlectric power resources, but it would also mean greater utility for steam generation at the mines, as mentioned on page 55.





## PETROLEUM

The United States possesses between fifteen and twenty percent of the total world reserves of petroleum, but our production ranges between sixty and seventy percent of the world's total consumption. By the end of 1934 we had produced approximately 16,000,000,000 barrels of crude petroleum. An amount representing about half of our original supply under present methods of production. All evidence points to the fact that we have but ten to fifteen years of known cheap supplies at<sup>1</sup> the present rate of consumption.

"I challenge any other present day industry in the United States to show greater waste, inefficiency and mismanagement than seem to be inherent in the oil industry, whether of its own making or because of inadequate laws. These are grave dangers, but they are less grave than the situation to which<sup>2</sup> they relate.

The coal industry has been justly charged with waste, but so much more serious, extensive, and wanton is the waste in the oil industry that the two are beyond comparison. Oil is taken not according to how much can be used, but how much can be taken. As a consequence, the markets of the world have for years been flooded with cheap American oil. Until very recently, the natural gas was permitted and even helped to escape into the air. No attempt was made to save it.

1 Ickes, Harold L, Secretary of the Interior. After the Deluge, What Price Gasoline?, Saturday Evening Post, Feb. 16, 1935, p.6

2 Ibid.





This all means unmeasurable loss to the American people, but it also means short life to the possible competition that petroleum can give coal. And likely, it means the necessity of substituting bituminous coal for petroleum in many instances.

A dollar's worth of petroleum possesses slightly less thermal value than a dollar's worth of coal, but in its principal uses, petroleum is far superior because of its natural liquid state. About sixty percent of the petroleum becomes gasoline; the remainder a number of products such as fuel oil, lubricating oil, and greases.

Electric Central Stations use on an average of 8,000,000 barrels of petroleum per year; an insignificant amount representing but one percent of the annual production of petroleum. This is about the only competition afforded coal in the field of industrial power generation.<sup>1</sup>

Petroleum competes with bituminous coal in the transportation field directly in ocean and land freight and passenger transportation and indirectly in automotive transportation.

Locomotives consume about forty million barrels of petroleum a year, used mostly in sections of the country where petroleum is plentiful and coal is scarce.<sup>2</sup> Steamships use twenty million barrels of petroleum which is a far superior fuel for this purpose.<sup>3</sup> It is absolutely essential that all naval vessels be oil burners because of the greater flexibility

1 Minerals Year Book 1932-33, p.396

2 Ibid.

3 Ibid.





of control and less time required in getting underway. Motor trucks compete with the railroads in short hauls of freight, and busses compete in all types of passenger haulage. Likewise, the automobile has made serious inroads upon all types of rail transportation for individuals. The railroads have suffered this motor competition and have maintained their position, by a wide margin, as the principle overland transportation system. It is not likely that this competition will increase in the future, and if the railroad rates should be lowered, much of it would cease.

The new stream-lined Diesel powered trains do not offer much of a challenge to coal in railroad transportation. They are suitable only for long run passenger haulage. It is well known that the passenger revenue of railroads is small, and in many cases passenger transportation is carried on at a loss. Many railroads would be only too glad to be permitted to abandon their passenger service. The Diesel powered unit is not applicable to freight haulage. It has the advantage of combining great power with light weight, but great weight in the power unit is a physical necessity for hauling heavy freight trains. It is one thing to build a Diesel engine the size of a house to propel an ocean liner, but quite a different thing to adopt such an engine to railroad service. Track gauges and bridge and tunnel clearance place very definite restrictions on size of power units.<sup>1</sup>

1 Willard, Daniel, President of The Baltimore and Ohio Railroad, quoted from The Saturday Evening Post, Nov. 3, 1934, p.13.





With the threat of depletion of petroleum reserves, bituminous coal bids fair to offer decided competition in the future as a motor fuel. Benzol is extensively used in Europe in place of gasoline, and it will eventually be used in automobiles in this country. It is highly satisfactory, and in one respect at least, it is superior to gasoline. It has a lower flash point with resultant easier starting. As a matter of fact, the highly advertised "quick starting" gasolines on the market today contain up to forty percent of benzol.

Notwithstanding the fact that oil heating is gaining favor, it is competing with anthracite rather than with bituminous. Even though petroleum should become the leader in the heating field, it could not last because heating would simply offer another way to use up a rapidly disappearing resource. With the depletion of petroleum, bituminous coal offers the only alternative. Regardless of all the conveniences of oil as medium of heat, bituminous coal, by virtue of the gas derived therefrom, offers a more convenient and far more dependable medium.

In consideration of the future aspects of competition between petroleum and coal it must be born in mind that petroleum is too near exhaustion to be a significant factor. Petroleum can offer competition in the immediate future only, and is bound to lose its competitive position within a few decades at most.





## NATURAL GAS

Natural Gas is disappearing the most rapidly of all our energy resources. Its occurrence is practically confined to the petroleum pools. It supplies the pressure that forces the oil out of the ground in "gushers". In many instances the gas was struck before the oil in drilling of wells and allowed to escape into the air while the operators waited for the oil to run in and take its place. When the gas is exhausted the oil must be pumped out, a process which adds to the cost of production. Because of factors surrounding its occurrence, and because of past practices in the production of petroleum, natural gas will be come depleted long before the oil wells, the life of which is none too long.

Gas can be used only for industrial power or for household fuel. Electric utilities used about 108,000,000,000 cubic feet in 1932, a decline of twenty-three percent from the 1925-29 average. The decline in consumption is accounted for by the increased use of hydro-electric power, mostly in California<sup>1</sup>

Natural Gas affords but very feeble competition with bituminous coal, and, because of the very limited reserves, it cannot continue in competition for any important length of time. Thus natural Gas as a future competitor of coal is not a factor.

1 Minerals Year Book 1932-33, p.397





## FOREIGN COMPETITION

Foreign competition with American Coal mines is not an important factor. A small amount is occasionally imported from England and Russia, but the English coal is confined, as a rule, to highly Specialized metallurgical coal, and the Russian coal represents excess production shipped over here to be sold for what it will bring. The only regular importation represents that shipped to the Pacific North-West from South-Western Canadian mines. It is much cheaper to import Canadian Coal at Seattle or Portland, Oregon than to transport it from interior or eastern fields. These imports from Canada should and will continue because they represent an economic advantage. Likewise, Canada is the largest importer of coal from the United States. Her industrial centers in the Province of Ontario can use coal from the United States, mined near the shores and transported via the Great Lakes, more cheaply than they can transport it from the more distant mines. The future holds little danger of increasing competition from coal mined in other countries. Save for a few isolated cases, the coal in this country is so abundant and so well distributed that foreign coal is at a distinct disadvantage from a competitive standpoint.





ASPECTS OF THE EFFECTS OF COMPETITION  
ON THE FUTURE CONSUMPTION OF BITUMINOUS COAL

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Hydro-electric power is the only energy resource, other than coal, that has any semblance of permanence, and it is the only one in which there is much possibility of expansion. It has already been pointed out, however, that water power is sufficient to supply only half of our present industrial requirements, and that about two-fifths of it has been developed to date. Thus, if all the potential power could be immediately developed and made available for industry, it could not take more than a third of the demand for industrial power. And, since about a third of the annual output of coal is used to furnish industrial power, hydro-electric generation could take only about one-ninth of the total demand for coal. It has been shown that there are very definite restrictions on the application of water power which make it unlikely that this resource can be developed and used in the immediate future to an extent that will threaten the present markets for bituminous coal. Besides the limited amount of water power available and the limitations on its application, the difference in the ultimate cost of hydro-electric generation and steam generation is not sufficient to warrant any extensive relocation of industry for the purpose of taking advantage of it. Of course there is the possibility that the government will make the undeveloped power available by subsidizing its development.





Following this there is a very real probability that the governmentally subsidized power will be offered to the consumers at a price which does not cover its entire cost including interest on capital investment. In such a case the taxpayers would be supplying power to those fortunate enough to be located within the area of its economical distribution. But the injustice of a like arrangement would cause such enthusiastic objections on the part of industry as a whole, that a policy of making the governmentally controlled power pay its own way would be shortly put into effect.

Any hydro-electric power made available in the future would necessarily be used by consumers who would otherwise have to use coal. To this extent will water power take the future increase in demand from coal. However, because of the limited amount available and because of its adverse location in respect to the probable industrial expansion of the future, hydro-electric power could check the growth in the demand for coal for but a very short time, and could diminish the present demand for a much shorter time, if at all.

Petroleum has rivalled coal principally in the transportation field. Automotive transportation of freight and passengers has reached the saturation point as a long distance medium, the only phase of automotive transportation to cause the railroads any great concern. More efficient railroad operation, along with increasing legal restrictions on the free use of highways will tend to diminish the chance of increased competition in this field.





The oil-burning steam locomotive is being used in sections of the country where coal is scarce. It cannot come into general use for the resultant increase in the demand for petroleum would raise the price to a prohibitive level. Also, coal represents a very significant item of railroad freight and the carriers would not take the lead in encouraging the substitution of petroleum, transported mainly by pipe lines, for coal, their best customer.

Since the exhaustion of the petroleum reserves is within sight, it promises to be less and less of a competitor as time progresses. Natural gas is in much the same position as petroleum in regard to future competition. The main difference is that the gas will be exhausted much the sooner.

There is no promise of increasing competition from foreign mines. It is only under rigidly ordered circumstances that foreign coal can compete; such circumstances existing at present are likely to continue much the same in the future, but they will permit no increasing importation.





Note in reference to the last paragraph on page 112.

The contention that motor trucks receive an unfair advantage through being permitted to use the public highways is persistently advanced by the railroads. The companies claim that because their investors have built and maintain their own rights-of-way they should be protected from competition. On the other hand it is contended that if one form of transportation proves more efficient than another, there is no economic basis for preventing a substitution, and it is further pointed out that because of superiority, the railroads were permitted to replace the turnpikes and the canals. The railroads, however, are trying, through governmental pressure, to do away with motor truck competition, and they may succeed. In any event the carriers do not have to sit by and see their source of revenue taken from them, for, if it is so profitable, they can go into the trucking business and offer free pick up and delivery service that will lick the motor truck enterprises at their own game.





# CONCLUSIONS POSSIBILITY OF OBSOLESCENCE OF PRESENT MARKETS

The industrial primacy of bituminous coal remains unchallenged. Doubtless some of the present coal consuming industries will become obsolete, but new ones will take their place and will use coal. The artificial ice plant is being replaced by the electric refrigerator, but coal supplies the energy to run either. Any important industry entering the field will use power, and any power using industry must depend on coal.

The only general trend toward a decreased use of coal is found in fuel economy. The high price of coal has brought fruitful research with the result that technical improvements have made it possible to get a given amount of power from a smaller amount of coal. Between 1920 and 1929 there was a marked improvement in the amount of power that could be derived from a given amount of coal. The following chart shows the decrease between 1920 and 1929 in the amount of coal necessary to create a specified amount of power:-

|                                              | <u>Percent reduction in<br/>coal consumption</u> |
|----------------------------------------------|--------------------------------------------------|
| <u>I</u>                                     |                                                  |
| Electric Utility power plants - - - - -      | -66%                                             |
| Steam Railroads - - - - -                    | -40%                                             |
| Petroleum Refining- - - - -                  | -36%                                             |
| Iron Furnaces, Steel Works, Rolling Mills -  | -25%                                             |
| Cement Mills - - - - -                       | 21%                                              |
| All other Manufacturing- - - - -             | 21%                                              |
| Average of all Industries and Railroads- - - | 33%                                              |





The total saving in 1929 over 1920 was 210,000,000 tons. In other words, industry got the same amount of power out of 550,000,000 tons in 1929 as would have been obtained from 760,000,000 tons in 1920.<sup>1</sup> That such an increase in the efficiency of utilization can be accomplished is either an indictment of industry for its past wastefulness or a compliment to its ingenuity. It does not mean that less coal will be used, but that more coal will be used with greater effectiveness. As a matter of fact, there was approximately more coal used in 1929 than in 1920, but forty percent more work was accomplished with it. Thus, the economies have the effect of postponing the day of depletion rather than of reducing demand.

It has already been shown that petroleum dealt its blow and is no longer a threatening factor. If it takes any more of the present markets for coal, it will do so only to shortly lose them. Hydro-electric power offers a threat but, because of its limitations, it is a mild one. Natural gas is at the moment losing ground and is out of effective competition. Foreign competition never has been and probably never will be an important competitive factor.

1- Minerals Yearbook 1932-33, P. 382.





POSSIBILITIES OF INCREASED CONSUMPTION OF  
BITUMINOUS COAL

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The promise of increasing consumption of bituminous coal through general industrial expansion, though ethereal, is worth considering. At present the nation is at a standstill. The phenomenal march of industrial progress that has been one and the same with this nation's history has come to a halt. The United States will continue to progress, however, but at a normal rate for a mature nation. Until the period of depression commencing in 1929, it was estimated that the population of this country would reach 200,000,000 or over within a short time. Such estimates have since been drastically cut down. It is probable that the population will reach 150,000,000 within several generations, but a higher estimate on the bases of current indications would be quite unconservative. An increase of 25,000,000, or twenty percent, would necessitate a proportionate increase in the consumption of coal. Any increase in general industrial activity would necessitate a like increase in the use of coal because modern industry is basically dependent upon power, and future power must come from coal. There is also the possibility that the United States will become a more prominent exporter of manufactured goods. At present our export trade amounts to ten percent of our total, a small percentage for an industrial nation. Any significant increase in exports would bring an increase in industrial activity.





There is more promise in the application of coal to new uses. Household heating will inevitably fall back on bituminous coal. The world reserves of anthracite, the common household fuel in the United States, are pitifully small. Those of this country can last, at the present rate of consumption, but a few generations. Petroleum, for the same reason, cannot take its place. Bituminous coal can be applied to this use as gas, coke, electricity, or artificial anthracite. Thus it is applicable to the new as well as the old ways of heating. Household heating will eventually add 100,000,000 tons to the annual consumption.

Benzol will some day rival gasoline as a motor fuel. With exhaustion of the petroleum reserves in sight, the price of gasoline may easily rise to a point where benzol will be manufactured for its own sake rather than as a by-product.

The coal tar industries can easily reach great proportions. Development waits only on demand for its products, many of which are gaining importance daily. The possibilities are sufficiently great that this industry may easily use everything turned out by the by-product coke ovens as well as consuming a large amount of raw coal itself. It will supply raw materials for many industries yet to come.





COORDINATION  
- - - - -

There is but one industry where coordination is so completely absent and is vitally necessary and that is petroleum production. From the standpoint of lading coordination, petroleum is in the lead, but bituminous coal is running a very good second.

In the first place, there is no coordination within the industry itself. Supply and demand never coincide. The productive capacity is twice as large as necessary and the number of individual mines in operation is probably three times the number that could easily furnish the supply. There is no geographical coordination between the mines and the markets. Needless transportation is common. Coal from the Eastern fields competes with Illinois coal in Chicago, and Illinois coal is offered for sale to Eastern consumers. There is no effective coordination between production and transportation; a cause of needless transportation. Likewise there is none between coal and hydro-electric power. And not the least is the disorganization between the related industries of metallurgical coking, gas and coal tar manufacture.

These conditions are particularly objectionable because they concern a product of fundamental importance. The whole difficulty can be attributed to the competitive system of small-unit mining which has been perpetuated in the country by a public policy hostile to combination. The individual mine operator cannot be held responsible for he has faced the





opposition of the miners' unions, of governmental restrictions, and of probable financial loss. Coal cannot be mined effectively under the present system. Were it not for the great extent of the resource, it could not have withstood the competitive system. The conception of public utilities should be enlarged to embrace coal. Bituminous coal has become by its nature a public utility, and its administration as such is the only practical way out of the present difficulties. Integrated coal mining, under proper limitations, would reduce waste, stabilize production, adjust supply to demand, and lessen transportation. While the price of the coal to the consumer has been too high, the price of coal at the mine has been so low that it has been a small factor in the ultimate cost to the consumer.

The advantages of integration in coal production are well known in other countries. Coal is a resource that should be produced under a cooperative system. Coal does not lend itself to a graded extraction according to the strength of demand. A mine of commercial size represents a capital investment large enough to warrant production at a loss rather than idleness. And coal is the major source of power and the basis of modern living, therefore society should do its utmost to secure its most effective use.

Integrated mining would lessen the increased costs that will come with the exhaustion of thick-seam and easily obtainable coals. Reduced transportation would lower the





ultimate cost to the consumer. By-product utilization would give cheaper fuel through the advantageous use of all the values, it will reduce transportation and encourage the growth of a great coal-products industry that has immeasurable possibilities.

Production and utilization of coal are far behind the times. Economic forces may to some extent lessen the amount of over-production through the bankruptcy of many mines, but they cannot eliminate the industry's greatest hazard - that of potential coal. Because of its vital importance, widespread use, and scattered distribution, no form of control can be effective unless it originates in governmental authority.





SUMMARY

The bituminous coal industry is pathetically disorganized, yet it is capable of producing plenty of coal. So capable, in fact, that the industry suffers from chronic overproduction. There are far too many mines in operation with the result that the present productive capacity exceeds consumption two to three times. The more antiquated methods of extraction are in general practice. Because of the overcrowded condition of the industry, labor does not receive the income necessary to provide a comfortable living.

The high cost and wastefulness of the old extractive methods make it necessary for the mines to modernize and use machinery. But to modernize is to double or triple the productive capacity, which is already excessive. Mechanization of the mines will solve the problem of waste and high cost, but will leave an economic problem in its place unless the situation is brought under control. Control can be accomplished to some extent by economic pressure which may force the closure of the less efficient mines, or it can be accomplished through the reorganization of the industry on the basis of combinations. Before extensive combinations can be put into effect, the prohibiting Anti-Trust laws will have to be revised. The only other alternative is the inclusion of coal mining as a public utility.





The resources of bituminous coal are plentiful. There is no danger of exhaustion of the general supply for many centuries to come, but there is danger of the exhaustion of particular types adaptable to special purposes. These special reserves should be rigidly protected. Coal is widely distributed throughout most of the country. The geographic distribution is fortunate in relation to demand. There is a generous supply of the best grade near the foremost industrial section of the nation; the Middle Atlantic and Southern New England States. The Mid-Western industrial centers are also near an ample supply of good quality coal. In general, the highest quality coals are in the Eastern fields and the quality becomes progressively lower toward the West, but that in the West is a coal of good quality.

There is but little overlapping in occurrence of coal and the alternate resources such as hydro-electric power and petroleum.

Coal is the principal source of industrial power. About one-third of the annual production is used for that purpose. It is also the chief source of energy for over-land transportation. The railroads consume twenty-five to thirty percent. The metallurgical industries consume the major part of the remainder.

Hydro-electric power is the strongest competitor, but the total resource is insufficient to supply more than





half of the present requirements of industrial energy, and thirty-eight percent of it has already been developed. Petroleum and natural gas have been significant competitors in the past, but, because of their relative scarcity, they cannot continue to be important competitive factors.

Coal is the leading energy resource and it will maintain its leading position in the future. If some of the present industries go out of existence, it will be because they were superseded by others. The decline of particular industries will not decrease the demand for coal for those taking their place will have to depend on coal.

There is but little danger of bituminous coal yielding its markets to other resources. Hydro-electric power is limited in amount and application while the exhaustion of petroleum and natural gas is in sight.

There is some possibility of increasing the consumption of bituminous coal through general industrial expansion for coal must satisfy any increase in the demand for power. There are great possibilities for increasing the consumption of coal through the comprehensive development of a by-products industry. This has so far been neglected in the United States.

Coordination is severely needed in the industry and in its relationships with other industries. It may be





successfully accomplished through combinations, but the Anti-Trust laws are preventing coordination by that means. The surest way to secure effective coordination would be the inclusion of bituminous coal as a public utility.

"Coal is a resource requisite to the functioning of every other resource. The home, industry, and commerce are entirely dependent upon its adequacy. Coal is the basis of organized life. Other raw materials are merely parts of the social fabric - incidental to it; iron, for example, does not come to the consumer as such, but coal is comfort and energy as well as a commodity to be manufactured. Coal, therefore, in its far-reaching consequences, has assumed a responsibility equalled by no other substance." <sup>I</sup>

I - U. S. National Museum Bulletin 102, Vol. 1, p. 26.





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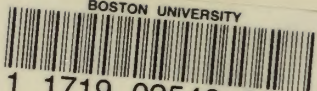


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